

IN THE UNITED STATES DISTRICT COURT  
FOR THE DISTRICT OF MASSACHUSETTS

DePuy Mitek, Inc.	)	
a Massachusetts Corporation	)	
	)	
Plaintiff,	)	
	)	
v.	)	Civil Action No. 04-12457 PBS
	)	
Arthrex, Inc., <i>et al.</i>	)	
a Delaware Corporation	)	
	)	
Defendants.	)	
	)	

**DEFENDANTS' OPPOSITION TO PLAINTIFF DEPUY MITEK'S MOTION TO  
STRIKE HEARSAY EXHIBIT AND ALL CITATION AND COMMENTARY THERETO**

Dated: September 15, 2006

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## **I. INTRODUCTION**

Defendants Arthrex, Inc. (“Arthrex”) and Pearsalls, Ltd. (“Pearsalls”) (together, “defendants”) submit this Opposition to Plaintiff DePuy Mitek Inc.’s (“DePuy Mitek”) Motion to Strike Hearsay Exhibit and All Citation and Commentary Thereto. Defendants first challenge the propriety of DePuy Mitek’s motion since it does not comply with Local Rule 7.1(a)(2), requiring that DePuy Mitek confer with defendants to attempt to resolve or narrow the issue. Defendants also establish that the Spectra brochure is admissible under several exceptions to the hearsay rule, including Rules 803(6), 803(17), 803(18) and 807. Defendants further establish that the Spectra brochure is admissible to the extent it is not being offered for hearsay purposes. For the reasons mentioned herein, DePuy Mitek’s motion should be denied.

## **II. DEPUY MITEK FAILED TO COMPLY WITH LOCAL RULE 7.1(a)(2), AND THEREFORE, ITS MOTION SHOULD BE STRICKEN**

Local Rule 7.1(a)(2) of the U.S. District Court for the District of Massachusetts requires that “[n]o motion shall be filed unless counsel certify that they have conferred and have attempted in good faith to resolve or narrow the issue.” DePuy Mitek makes no such certification because it can not.

The first defendants’ heard of DePuy Mitek’s objection to the Spectra brochure (Ex. 1) was when it was served with DePuy Mitek’s motion. Although DePuy Mitek had plenty of opportunity to do so, it did not even attempt to discuss its objection to the Spectra brochure with defendants prior to filing its motion. DePuy Mitek had at least three weeks during which it could have conferred with defendants regarding its objections yet it failed to do so. Even on the day its motion was served, although DePuy Mitek made a last minute call to defendants regarding its intent to request an extension of the 20-page limit in connection with its opposition to defendants’ summary judgment motion,<sup>1</sup> DePuy Mitek was silent on its intent to file this motion.

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<sup>1</sup> As explained below, it is now clear that DePuy Mitek’s filing of this motion is simply a transparent attempt to circumvent the page limits set forth in Local Rule 7.1(b)(4).

Had DePuy Mitek complied with the local rule, defendants would have had the opportunity to explain why the Spectra brochure is admissible or otherwise resolve the issue, and thus could have avoided burdening the Court with this unnecessary motion. At the very least, the parties could have narrowed the issues -- the express intent behind Local Rule 7.1(a)(2). Instead of working out its objection with defendants, DePuy Mitek apparently would rather burden this Court.

**A. DePuy Mitek's Motion is a Transparent Attempt to Circumvent The Page Limit Set Forth in Local Rule 7.1(b)(4)**

As explained above, DePuy Mitek made a last minute call to defendants on the day its opposition to summary judgment was due and notified defendants of its intent to request an extension of the 20-page limit set forth in Local Rule 7.1(b)(4). DePuy Mitek was silent, however, on its intent to file its motion to strike the Spectra brochure.

In the spirit of cooperation, defendants consented to DePuy Mitek's request to seek additional pages for its summary judgment opposition. Defendants consented even though DePuy Mitek's request was made at the last minute and just a few hours before the filing deadline. Defendants also consented even though the page increase would be unilateral and even though there was no prior discussion between the parties about jointly seeking a page increase, as they had done for their respective summary judgment motions.

It is now clear, however, that DePuy Mitek's motion to strike is nothing more than a transparent, calculated attempt to circumvent the Court's page limit. DePuy Mitek surely recognized that it could not seek more than 30 pages for its summary judgment opposition -- that is the amount the parties had agreed upon, and the Court had approved, for the parties' respective opening summary judgment memoranda. It also must have known by then that it could not fit all of its arguments into the newly-expanded page limit of 30-pages. Rather than playing it straight with defendants -- and the Court -- DePuy Mitek had a hidden plan to make its objections to the Spectra brochure in a separate motion.

Such actions should not be countenanced. On this basis alone, DePuy Mitek's motion should be denied without leave to refile. At a bare minimum, DePuy Mitek should be required to withdraw its motion, confer in good faith with defendants, and only be permitted to refile if resolution or narrowing of the issues can be achieved.

### **III. SHOULD THE COURT CONSIDER DEPUY MITEK'S MOTION ON THE MERITS, THE MOTION SHOULD STILL BE DENIED**

DePuy Mitek asserts that the Spectra brochure should be stricken because it is hearsay and there are no exceptions to the hearsay rule that apply. Plaintiff DePuy Mitek's Memorandum in Support of Motion to Strike Hearsay Exhibit and All Citation and Commentary Thereto ("Mitek Mot. to Str.") at 3. But DePuy Mitek discusses only two exceptions to the hearsay rules -- the business records exception (FED. R. EVID. 803(6)) and the learned treatise exception (FED. R. EVID. 803(18)). Not only is DePuy Mitek wrong about these exceptions, as we show below, but it leaves out two other exceptions -- the commercial publications exception (FED. R. EVID. 803(17) and the residual hearsay exception (FED. R. EVID. 807) -- that also serve as grounds for admission. Finally, we show that DePuy Mitek is wrong in its conclusory assertions that defendants are offering the Spectra brochure for the truth of the matter asserted. The brochure is also offered for non-hearsay reasons. Accordingly, even if an exception does not apply, the brochure should still be admitted with at most a limiting instruction.

#### **A. Since DePuy Mitek Produced the Spectra Brochure in Response to a Document Request, It has Been Authenticated and is Admissible under Fed. R. Evid. 803(6) as a Business Record**

DePuy Mitek asserts that the Spectra brochure "cannot qualify as a business record." Mitek Mot. to Str. at 3. DePuy Mitek is wrong. As explained below, the Spectra brochure is admissible as a business record. Conspicuously absent from DePuy Mitek's motion is any mention of the fact that it was DePuy Mitek that produced the Spectra brochure to defendants in response to a document request. Specifically, DePuy Mitek produced the Spectra brochure on June 21 2005, and it bears the DePuy Mitek bates number range "DMI003378-3390. Ex. 1.

Since DePuy Mitek produced the Spectra brochure in response to a request for its documents, the Spectra brochure is admissible as a DePuy Mitek business record. *See, e.g., John Paul Mitchell Sys. V. Quality King Distributors, Inc.*, 106 F.Supp.2d 462, 472-73 (S.D.N.Y. 2000). *John Paul Mitchell* involved a situation almost identical to here. In that case, documents were produced in response to a discovery request. There, as here, the producing entity did not generate the documents that were produced. When the admissibility of those documents was challenged, the court reasoned that the act of production indicated the producing entity's belief that the documents were responsive to the requests and that the documents were maintained in the ordinary course of the producing entity's business. Thus, the document was admissible as a business record pursuant to FED. R. EVID. 803(6). *Id.* at 472. The same is true here. The act of production by DePuy Mitek indicates its belief that the documents are responsive to defendants' document requests and that the documents were maintained in the ordinary course of DePuy Mitek's business. That makes the Spectra brochure admissible as a business record.<sup>2</sup>

**B. The Spectra Brochure is Admissible Under Fed. R. Evid. 803(17) as a Commercial Publication**

FED. R. EVID. 803(17) excludes from coverage of the hearsay rule "[m]arket quotations tabulations, lists, directories, or other published compilations, generally used and relied upon by the public or by persons in particular occupations." DePuy Mitek does not consider this exception in its motion. The First Circuit has held that a manufacturer's published catalog was

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<sup>2</sup> DePuy Mitek also implies that the Spectra brochure is not authentic. Mitek Mot. to Str. at 2 ("although it allegedly was created by someone within Allied Signal even this has not been properly established.") The law is clear that the production of a document in response to a document request serves to authenticate the document. *See Sprinkle v. Lowe's Home Centers, Inc.*, 2006 WL 2038580 (S.D.Ill. 2006) (Ex. 2) (stating that "when a party has produced the document in question in response to a subpoena or discovery request, he has implicitly authenticated the document"). *See also Tracinda Corp. v. DaimlerChrysler AG*, 362 F.Supp2d. 487, 500 (D.Del. 2005) (citing *John Paul Mitchell* and stating that "documents were authenticated when they were produced by the party against whom they were offered"); *Wechsler v. Junt Health Sys., Ltd.*, 381 F.Supp.2d 135, 153 (citing *John Paul Mitchell* and stating that "production of documents by an adversary also factors into a Court's decision on the authenticity of a document").

admissible under Rule 803(17) as a published compilation generally used and relied upon by retailers in the particular field of cigarette lighters. *United States v. Grossman*, 614 F.2d 295, 297 (1st Cir. 1980). *See also Susemihl v. United Steamship Co., Ltd.*, 859 F.2d 150, \*2 (4th Cir. 1988) (Ex. 3) (citing *United States v. Grossman* and finding tile manufacturer's catalog was admissible under Rule 803(17) as a published commercial compilation generally relied upon by potential purchasers of the manufacturer's products).

Similarly, the Spectra brochure states that it was published by Allied Fibers Technical Center, P.O. Box 31, Petersburg, Virginia 23804, and it bears a copyright date of 1988. Ex. 1 at 2. On its face, the Spectra brochure is a commercial publication providing information to the public on Allied's extended chain polyethylene fibers, also known in the art as ultra high molecular weight polyethylene ("UHMWPE") fibers. Even DePuy Mitek refers to the Spectra brochure as a "*commercial marketing brochure*." DePuy Mitek Brief in Response to Arthrex's Claim Construction Brief at 4. As such, it is admissible as a commercial publication under FED. R. EVID. 803(17).

**C. The Substance of the Spectra Brochure is Admissible Under Fed. R. Evid. 803(18) as a Learned Treatise**

**1. Dr. Mukherjee establishes the Spectra brochure as a learned treatise**

FED. R. EVID. 803(18) excludes from coverage of the hearsay rule "statements contained in published . . . pamphlets on a subject of . . . science or art . . . established as a reliable authority by the testimony or admission of the witness or by other expert testimony or by judicial notice."

This hearsay rule exception applies when an expert relies on the statements and the expert's testimony or judicial notice establishes the document as a reliable authority. *See, e.g., Caruolo v. John Crane, Inc.*, 226 F.3d 46, 55 (2nd Cir. 2000). Defendants submit the declaration of its expert, Dr. Mukherjee, stating that he knows that Spectra is a tradename of UHMWPE and that brochures of this type are reliable authorities because manufacturers of these types of

products are in the best position to provide accurate descriptions of the product, the history of the product development and a comparison to related products. Ex. 3 at ¶ 3. Dr. Mukherjee's declaration establishes that the statements in the Spectra brochure are accurate. There are many well-known and significant differences between general purpose (or commodity type) polyethylene and UHMWPE and that those well-known and significant differences are accurately disclosed in the Spectra brochure. Ex. 3 ¶¶ 6-11. Dr. Mukherjee also states that the Spectra brochure supports prior statements regarding those differences that he has made in his expert reports. Ex. 3 at ¶ 4. Thus, Dr. Mukherjee establishes the Spectra brochure as a reliable authority under Rule 803(18) and the statements included in the Spectra brochure which Dr. Mukherjee so establishes as being reliable are admissible under the Rule 803(18). *Caruolo v. John Crane, Inc.*, 226 F.3d at 55 (stating that study was admissible as learned treatise under Rule 803(18) since proponent's expert relied on it to support his testimony).<sup>3</sup>

2. Dr. Hermes established the Spectra brochure as a learned treatise

DePuy Mitek wrongly asserts that "there is no substantive testimony about the brochure at all." Mitek Mot. to Str. at 3. Once again, DePuy Mitek misstates the facts. When presented with the Spectra brochure at his deposition, DePuy Mitek's expert, Dr. Hermes, testified that he is familiar with Spectra and that he understands it to be UHMWPE. Ex. 4 at 314:21-315:4. Dr. Hermes also testified that he had heard the term "commodity" type polyethylene, as described in the Spectra brochure. Ex. 4 at 315:15-17.

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<sup>3</sup> DePuy Mitek cannot assert that it will somehow be unduly prejudiced by Dr. Mukherjee's declaration because it will have the opportunity to cross examine Dr. Mukherjee at trial and it will also have the opportunity to elicit additional testimony about the Spectra brochure from its own experts. *See, e.g., id.* (even though first mention of the study was not until expert's re-direct testimony at trial, admission of the study was not overly prejudicial since there was opportunity to cross examine expert and to elicit additional testimony from objecting parties' own expert).

Further, Dr. Hermes acknowledged that the Spectra brochure distinguishes between commodity polyethylene and UHMWPE, based upon molecular weight and that he agreed with the molecular weight attributed to UHMWPE by the Spectra brochure. Ex. 4 at 316:25-317:23. Dr. Hermes also acknowledged that the specific range for molecular weight attributed to UHMWPE by the Spectra brochure is “the range that gets quoted in a lot of publications.” Ex. 4 at 317:24-318:2. Dr. Hermes also testified that he understood that the authors of the Spectra brochure are saying “that the molecular weight of [UHMWPE] is substantially higher than the molecular weight of conventional [commodity] PE.” Ex. 4 at 319:4-20. Dr. Hermes further acknowledged that the Spectra brochure explains that the strength of conventional PE is different than the strength of UHMWPE and that it describes UHMWPE as, pound for pound, one of the strongest materials made. Ex. 4 at 328:9-12.

Thus, to the extent Dr. Hermes has established certain statements contained within the Spectra brochure as being reliable -- and there are many such statements -- they should be admissible under Rule 803(18).

**D. The Spectra Brochure is Admissible Under Fed. R. Evid. 807, the Residual Hearsay Exception**

A district court may admit hearsay documents pursuant to FED. R. EVID. 807 where (i) the hearsay is particularly trustworthy, (ii) the hearsay bears on a material fact, (iii) the hearsay is the most probative evidence addressing the fact, (iv) the proffer follows adequate notice to the adverse party, and (v) the admission is consistent with the rules of evidence and advances the interests of justice. *See, e.g. John Paul Mitchell*, 106 F.Supp.2d at 473. As in *John Paul Mitchell*, all of these criteria are met here.

The trustworthiness of the Spectra brochure is established by its appearance, by the fact that it was produced by DePuy Mitek and by Dr. Mukherjee’s declaration. The differences between general purpose PE and UHMWPE are material to the litigation. The Spectra brochure

is probative of those material facts. DePuy Mitek has known about the Spectra brochure at least as early as June 21, 2005, when it was produced from DePuy Mitek's files, yet it waited until the 11th hour (and without complying with the meet and confer rules) before filing its motion. In light of the fact that DePuy Mitek produced the document, experts for both sides have agreed with the statements contained therein, on its face it is a commercial publication of Allied Signal, and DePuy Mitek's actions smack of gamesmanship in the extreme, the admission of the Spectra brochure would be in the interest of justice. *See, e.g., id.* (finding documents produced in response to document request admissible under both Rule 803(6) and Rule 807).

**E. The Spectra Brochure is Admissible Since it is Offered for Non-Hearsay Purposes**

DePuy Mitek assumed that the only reason that the brochure is submitted is to prove the truth of the matters contained therein. Mitek Mot. to Str. at 2. This is not true. One of the purposes of the brochure is to establish that the players in the relevant industry understand that "general purpose PE" and UHMWPE are different things, have different histories, and serve different purposes. For this purpose, it does not matter whether the statements about the differences are true. What is important is that the industry believes they are different products. That is not hearsay because it is not offered for the truth of the matter asserted. 2 MCCORMICK ON EVID. §§ 249, 295 (6th ed.). It must be noted that throughout its submissions, DePuy Mitek has accused defendants of making up distinctions between UHMWPE and general purpose PE without support. The Spectra brochure is a non-hearsay document designed to refute such allegations regardless of the accuracy of the distinctions drawn in the document between UHMWPE and general purpose PE.

#### **IV. CONCLUSION**

For all the foregoing reasons, DePuy Mitek's motion should be denied.

Dated: September 15, 2006

Respectfully submitted,

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**CERTIFICATE OF SERVICE**

I HEREBY CERTIFY that a true and correct copy of the foregoing Defendants' Opposition to Plaintiff DePuy Mitek's Motion to Strike Hearsay Exhibit and All Citation and Commentary Thereto was served, via the Court's email notification system on the following counsel for Plaintiff on the 15th day of September 2006:

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# Exhibit 1



EXTENDED-CHAIN FIBER

**SPECTRA®**  
**EXTENDED CHAIN**  
**POLYETHYLENE FIBERS**

*DePuy Mitek, Inc. v. Arthrex, Inc.*  
*C.A. No. 04-12457 PBS*  
*DMI003378*

# **SPECTRA<sup>®</sup>**

**HIGH PERFORMANCE FIBERS  
FOR REINFORCED COMPOSITES**

Published by  
Allied Fibers Technical Center  
P.O. Box 31  
Petersburg, Virginia 23804  
804/520-3321

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for its series of ultra high strength fibers

*DePuy Mitek, Inc. v. Arthrex, Inc.*  
*C.A. No. 04-12457 PBS*  
**DMI003379**

# SPECTRA® EXTENDED CHAIN POLYETHYLENE FIBERS

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## 1. HISTORY

Extended Chain Polyethylene (ECPE) fibers are the most recent entrants in the high performance fibers field. SPECTRA® ECPE, the first commercially available ECPE fiber, was introduced in February 1985. They are the first in a family of extended chain polymers manufactured by Allied-Signal Corporation.

SPECTRA® ECPE fibers are, pound for pound, the highest modulus and strongest fibers ever made. This is a noteworthy achievement on two counts. First, because industry had relegated it to the status of a general purpose commodity polymer, polyethylene was not considered as a specialized high performance product. Second, the discovery was not made in a large industrial polymer laboratory, but from fundamental work by researchers in several leading universities. Although the work was supported by industry, the immediate outcome was not foreseen as a commercial entity. It is, however, an example of industry recognizing the value of revolutionary findings and exploiting the promise of technology. The result was the transformation of a commodity type polyethylene (PE) plastic into a high performance fiber.

Today, ECPE fibers are being utilized as a reinforcement in areas that, five years ago, were not accessible to any organic fiber. Applications such as ballistic armor, impact shields, and radar domes are being developed to take advantage of the unique properties of ECPE.

## 2. CHEMISTRY

SPECTRA® fibers are made from ultra-high molecular weight polyethylene (UHMPE). In contrast to aramids, PE is a flexible molecule which normally crystallizes by folding back on itself. As a consequence, PE fibers made by conventional technology do not possess outstanding physical properties. ECPE fibers, on the other hand, are manufactured by a process where most of the molecules are fully extended and oriented in the fiber direction, resulting in a dramatic increase in physical properties. A simplistic view of the structure on a molecular scale could be described as a bundle of rods, with occasional entangled points that tie the structure together. Conventional PE, on the other hand, contains a number of chain folds of short length which do not make a contribution to strength.

The key structural parameters that distinguish ECPE fibers from conventional melt spun materials are further illustrated in Figure 1. The molecular weight of UHMPE is generally 1 to 5 million, whereas conventional PE fibers are typically 50,000 to several hundred thousand. SPECTRA® fibers also exhibit a very high degree of crystalline orientation (95-99%), and crystalline content (60-85%).

## 3. MANUFACTURING

Two general routes can be used to achieve high-modulus PE fibers. The first is by extrusion, such as melt extrusion or by solid-state extrusion, utilizing lower molecular weight PE polymer and specialized drawing techniques. These processes lead to a fiber with high modulus, but relatively low strength and high creep. The second route involves solution spinning, where very high molecular weight PE can be utilized. With this process modification, a fiber with both high modulus and high strength is produced.

The solution spinning process for a generalized extended chain fiber begins with a polymer of approximately 1-5 million molecular weight, which is dissolved in a suitable solvent. The solution serves to disentangle the polymer chains—a key step in achieving an extended chain polymer structure. The solution is fairly dilute but viscous enough to be spun using conventional melt spinning equipment. The cooling of the extrudate leads to the formation of a fiber which can be continuously dried to remove solvent or later extracted by an appropriate solvent. The fibers are generally post drawn prior to final packaging.

Unlike most high performance processes, the solution spinning process is unusually flexible, providing an almost infinite number of process and product variations. Fiber strengths from 375 KSI to 560 KSI and tensile moduli of 15 MSI to 30 MSI have been achieved on a research scale by various companies worldwide. As the solution spinning process is modified, a higher tenacity (stronger) and more thermally stable yarn is produced. Circumstantial evidence (such as increased density, heat of fusion and x-ray orientation pattern) suggests that the increased strength and stability are caused by higher degrees of molecular orientation.

## 4. APPLICATIONS

### 4.1 Fiber Properties

The comparative strengths of ECPE fibers versus other high performance fibers are summarized in Table 1. SPECTRA® 900, produced by Allied-Signal, will be used to illustrate the general properties of ECPE. SPECTRA® 1000 fibers are more stabilized, and exhibit a higher strength and modulus. In engineering terms, the tensile properties of ECPE are similar to many high performance fibers. However, because of the low density of PE (approximately 2/3 that of high modulus aramid and half that of high modulus carbon fiber), SPECTRA® fibers have extraordinarily high specific strengths and specific moduli. Pound for pound, the strength of SPECTRA® fiber is at least 35% greater than high modulus aramid or S-Glass, and about twice that of conventional high modulus carbon fiber. When comparing high performance fibers, it is often informative to employ a graphical illustration of Table 1. A two-dimensional plot of specific strength versus specific modulus for currently available fibers is given in Figure 2, again emphasizing the superior properties of SPECTRA®.

Polyethylene is also known as a system where traditional binders and wetting agents have proven to be ineffective in improving adhesion levels. ECPE fibers have shown that this characteristic is actually advantageous in specific areas. For instance, ballistic performance is inversely related to the degree of adhesion between the fiber and the resin matrix. For applications which need higher levels of adhesion and wetout, extensive research has been performed on SPECTRA® fibers. It has been found that by submitting the fiber to specific surface treatments, such as corona discharge or plasma treatments, the adhesion of the fiber to various resins is dramatically increased (see Table 2).

The main application areas being explored and commercialized today for SPECTRA® fibers are divided into two main thrusts: traditional fiber applications such as sailcloth, marine ropes, cables, sewing thread, nettings, and protective clothing; and high tech composite applications, such as ballistics, impact shields, medical implants, radomes, pressure vessels, boat hulls, sports equipment, and concrete reinforcement.

### 4.2 Sailcloth

World class competition of high performance sail boats (such as the Americas Cup) has become more competitive, forcing the sail industry to experiment with new materials. A winning sailcloth must possess high strength, high modulus, light weight and minimal distortion during the sailing season. Of the fiber physical properties, none are more critical than low creep and resistance to sea water and cleaning agents. Because of its superior strength-to-weight ratio and low creep response, SPECTRA® 1000 fibers are ideally suited for high performance yachting sails. Further, PE fibers are resistant to sea water and to typical cleaning solutions used in the boating industry, such as clorox (see Figure 3).

The creep behavior of SPECTRA® extended-chain fibers under typical laboratory test loadings of 3-4 gram/denier is illustrated in Figure 4. These creep levels are substantially below those encountered with conventional PE or the specialized high modulus fibers from melt spinning. At this loading, which includes the initial elastic loading component, the creep level of SPECTRA® 1000 is comparable to that of a high modulus aramid. The elastic load component is included in these results on a practical basis since it is an integral part of the sail cloth design.

### 4.3 Marine Ropes

High strength, light weight, low moisture absorption and excellent abrasion resistance all make ECPE a natural candidate for marine rope. Three parameters of SPECTRA® 900 rope (diameter, weight per length, and strength) are illustrated in Table 3. Since aramid fibers are the accepted standard in the high performance rope industry, aramids will be used here to provide a yardstick by which the ECPE fibers can be measured. SPECTRA® 900 braid is 12% smaller, 10% stronger and 52% lighter than the aramid product.

The important considerations in marine rope applications are load, cycling and abrasion resistance. The response of a SPECTRA® 900 rope to load cycling was measured by testing on a sheave device. The rope was repeatedly loaded to 4000 lb until it broke. In this type of test, a 12 strand ECPE braid withstood approximately eight times the number of cycles that led to failure in the control 12 strand aramid braid (Table 4). Abrasion resistance was measured by cycling the rope over an oscillating bar. In this test, 0.5 inch diameter ECPE braided rope withstood eight times the abuse of a similar aramid rope (Table 4).

### 4.4 Cut Resistant Gloves And Protective Clothing

The specially toughened and dimensionally stabilized SPECTRA® 1000 yarn has made a revolutionary new line of cut-resistant products. This technology offers a previously unattainable level of protection from cut and abrasion without sacrificing comfort and launderability. Spectra® fibers are being used in the form of cut resistant gloves, arm guards and chaps. Specific industries involved include: meat packing, commercial fishing, poultry processing, sheet metal work, glass cutting, and power tool use. The inert chemical nature combines with cut protection for non-permeable over-gloves in surgical, dental, laboratory testing, and police emergency response applications.

### 4.5 Ballistic Protection

ECPE's high strength and modulus and low specific gravity offer higher ballistic protection at a lower areal density than is possible with currently used materials. It can be used in flexible and rigid armor.

Flexible armor is manufactured by joining multiple layers of fabric into the desired shape. The style of the fabric and number of layers will determine the

ballistic resistance that the armor will provide. Typical V50 ballistic limits of plain weave SPECTRA® fabrics of different denier yarns are plotted as functions of areal density in Figure 5. Applications include protective vests for military personnel and civilian security forces as well as ballistic blankets. These blankets can be applied to ceramic and metallic armor as a front spall shield and as a rear spall suppressor. They can also be used to fabricate ballistic protective shelters.

Traditional rigid armor can also be made by utilizing woven ECPE fiber in either thermoset or thermoplastic matrices. These rigid systems exhibit high ballistic protection due to the fiber strength and modulus in combination with its low specific gravity; that is, maximum ballistic protection is achieved with minimum weight. This increased protection is illustrated in Figure 6, which compares V50 values for SPECTRA® fiber and aramid composites against a 22 caliber fragment simulator.

The ECPE fiber ballistic systems can be contoured or formed into armored plates, helicopter seats, Army or police helmets, and many other product forms. It is important for these systems to maintain their ballistic protection under a wide range of environmental conditions. For example, Figure 7 illustrates the superior performance of SPECTRA® fiber armor, even at temperatures as high as 225°F. This performance, along with the low moisture absorption, chemical inertness, and low weight characteristics make ECPE fibers a natural in the ballistic area.

## 4.6 Composites

ECPE fibers are recent entrants into the high performance composite industry. Their high strength and high modulus were the main attributes which attracted the composite industry, leading to the investigation of potential applications.

SPECTRA® fibers have been used with a wide variety of resin systems, including: epoxies, polyesters, vinylesters, silicones, urethanes and polyethylene. The choice of resin is most often dictated by the end use application and requirements. Epoxy and IPN resins provide the highest mechanical properties currently reported; epoxies being used most often by the composites industry, and IPNs gaining importance in RIM/RTM processes. Vinylester and urethanes, on the other hand, offer the greatest impact and ballistic properties at the expense of mechanical strength. Polyester is intermediate to the two groups, and is most often used in the radome industry for its electrical properties. ECPE fibers can be processed essentially the same as aramid, graphite, and glass. Hand layup, matched mold, pressure, and vacuum molding of fabric prepreps are most often used; however, filament winding and pultrusion are also common with continuous filament.

SPECTRA® fibers can be found in various forms; roving, fabric, continuous mat, and even chopped fiber. Composite applications where high strength (i.e. tensile, flexural, or short beam shear) are needed require special fiber treatments to enhance the fiber

to matrix adhesion. Allied-Signal, Inc. has developed proprietary treatments for their SPECTRA® fibers to increase the adhesion level and composite properties.

### 4.6.1 Composite Applications

SPECTRA® fiber reinforced materials are being developed and used widely in ballistics, radar protective domes, aerospace, sport equipment, and industrial applications. Some of these areas utilize the fiber in hybrid form, i.e. in combination with S-2 Glass, Graphite, Aramid, and/or Quartz.

Ballistics are so far the dominant market segment. Components include helmets, helicopter seats, automotive and aircraft armor, bullet proof radomes, and other industrial structures.

Radar protective domes (radomes) is another market utilizing ECPE fibers. Because of the excellent electrical properties of polyethylene, SPECTRA® composite systems act as a shield that is virtually transparent to microwave signals, even in high frequency regions. Hybridization with quartz or glass fiber are also attractive from the structural, cost, and performance point of view.

The major sport equipment applications to date have been canoes, kayaks, snow and water skis. Numerous other sport applications are under development, including: bicycles, golf clubs, ski poles, and tennis rackets. Further growth is expected in formula race car bodies.

The industrial market is taking advantage of SPECTRA® fibers in areas where increased strength, impact resistance, non-catastrophic failure, lightweight, or corrosion resistance are required. The corrosion resistance has led the composite industry to investigate applications where parts are exposed to a wide variety of chemical elements. Until now, standard high performance fibers could not function under such adverse conditions.

## 5. PROPERTIES OF COMPOSITES

The various fiber characteristics discussed so far can be translated into several unique composite properties. The following discussion will be organized into the following categories:

1. Ballistic
2. Impact
3. Electrical
4. Structural

### 5.1 Ballistic Performance

The ballistic performance of SPECTRA® fabrics has been presented as a function of areal density and fiber denier in the ballistic protection section. The excellent protection of SPECTRA® fabrics can be translated into hard armor composites. For example, ballistic protection against .22, .30, and .50 caliber threats is summarized in Figure 8. Looking back to Figure 6, one can see the advantage of SPECTRA® composites over similar composites reinforced with aramid fibers for fragmentation protection.

Handgun projectiles present a different type of threat, and again, SPECTRA® composites face up to the challenge with reduced weight and increased protection over aramid composites. The resistance to handgun ammunition of SPECTRA® and aramid composites are compared in Table 5. In every case, the SPECTRA® composites demonstrate lower areal density and/or increased protection.

## 5.2 Impact Resistance

Energy dissipation is one of the most outstanding features of ECPE. For instance, a comparison of fabric composites of SPECTRA®, Glass, Kevlar and Graphite under impact conditions is presented in Table 6. The SPECTRA® composite panels had significantly better impact properties, and were not "through penetrated" as the other panels were. Another unique behavior of SPECTRA® composites under impact loading is highlighted by repetitive impact studies. Figure 9 presents repetitive impact data for a similar SPECTRA® composite panel. Toughness gradually increases after each successive impact, working to extend the actual part life.

Drop weight instrumented impact tests were also performed on honeycomb sandwich composites. Again, the peak forces resisted by the SPECTRA® plates were consistently higher than similar aramid plates (Table 7). The peak impact force, total impact energy, and energy absorbed to peak force increase with the increase in face sheet thickness, from 1 to 3 plies. Resistance to hailstorm erosion is a practical example of the advantages that can be gained from the tremendous impact resistance offered by SPECTRA® honeycomb sandwich composites. A comparison with other reinforcements in a simulated hailstorm test is shown in Figure 10.

With the new surface treatments developed to enhance the fiber-resin interface adhesion, direct effects on the impact performance can be seen in Table 6. It should be noted that although the impact properties have decreased, the impact resistance of treated SPECTRA® composites is still five times that of glass or aramid, with a significant increase in physical properties.

## 5.3 Electrical Properties

Radar protective covers (radomes) are gaining an increasingly important role in today's radar systems. The most important attribute for a radome to possess is to be as close to "invisible" or "transparent" to the signal as possible. Because of the low dielectric constant and loss tangent of polyethylene, (see Table 8) SPECTRA® fiber composite systems can fulfill this requirement better than any other high performance fiber. The SPECTRA® composite low dielectric constant (2.3-2.5) has been shown to hold in the high frequency ranges, even up to the millimetric band. The superior electrical properties of ECPE fibers can be utilized in single fiber systems, or can be used to improve the properties of glass radomes via hybridization. A dielectric constant of 2.9 has been obtained with a SPECTRA®/Glass (25/75) hybrid system.

The advantages of low dielectric and low loss UHSPE fibers in radar systems can be demonstrated by observing the effect of the radome on the transmission ratio. The transmitted signal of a typical SPECTRA® radome matrix is compared with a glass radome at various ratios of wall thickness to wavelength in Figure 11. The SPECTRA® radome causes much less distortion of the signal. This advantage is even more pronounced in Type A honeycomb sandwich panels (Figure 12). By causing less signal reflection and absorbance, SPECTRA® fiber composite systems are uniquely suited to radome applications.

Other possible electrical applications for ECPE fibers and their reinforced composites are electrical shelters, x-ray tables, optical cables, and other structures where high strength non-conductive characteristics are needed.

## 5.4 Structural Properties

Static test results for SPECTRA® 900 and SPECTRA® 1000 unidirectional composites are summarized in Table 9. All test samples were cut from unidirectional prepregs of corona treated ECPE fiber with Shell Epon 825 epoxy resin and Mellamine 5260 cycloaliphatic diamine curing agent. The strength and modulus of SPECTRA® 1000 are higher than the SPECTRA® 900 composites, due to the improved strength of the SPECTRA® 1000 fiber. Further improvements in composite properties can be achieved by applying the plasma surface treatment to the fibers. This treatment increases the interfacial bonding, which translates into even higher composite structural properties, as described previously in Table 2.

The continuing research in improving the ECPE fiber-matrix compatibility along with hybridization with other high performance fibers open a wide new area in composite properties. These developments are currently being explored by scientists at Allied-Signal.

Figure 1. Fiber Morphology.

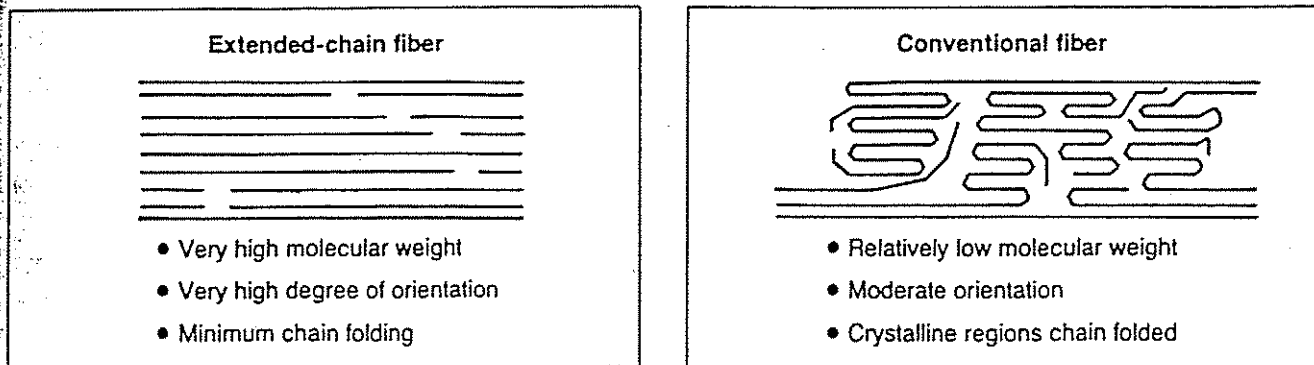
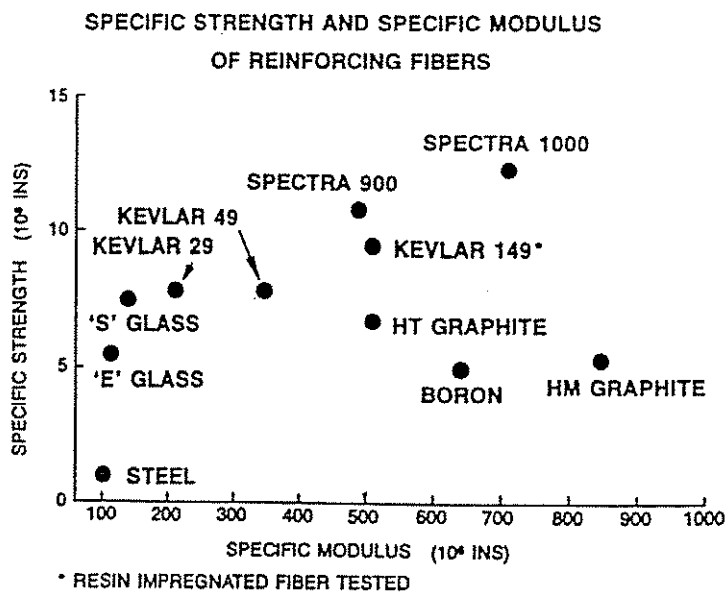


TABLE 1  
HIGH PERFORMANCE FIBER PROPERTIES

Property	UHSPE SPECTRA 1000	ARAMID HM	ARAMID UHM*	S-Glass	Graphite HM
Density	0.97	1.44	1.47	2.49	1.86
Elongation, %	2.7	2.5	1.5	5.4	0.6
Tensile Strength, 10 <sup>3</sup> psi	435	400	500	665	375
Specific Strength, 10 <sup>6</sup> in	12.4	7.8	9.5	7.4	5.4
Tensile Modulus, 10 <sup>6</sup> psi	25	19	25	13	57
Specific Modulus, 10 <sup>6</sup> in	714	365	480	140	850

\* Kevlar 149—Epoxy Impregnated Strand

Figure 2. Comparative tensile properties of various reinforcing fibers.



**TABLE 2**  
**UHSPE FIBER ADHESION IMPROVEMENTS**

Fiber: SPECTRA® 900

Resin: Epoxy

Fiber Loading: 60%

Date	Treatment	Unidirectional			Fabric (Style 903)		
		SBS (KSI)	Flex Str (KSI)	Flex Mod (MSI)	SBS (KSI)	Flex Str (KSI)	Flex Mod (MSI)
10/85*	TN <sup>1</sup>	1.16	21.2	1.2	0.87	5.7	0.44
10/86	CT <sup>2</sup>	2.61	27.6	2.6	1.4	10.3	1.0
10/87	TP <sup>3</sup>	4.50	33.9	4.5	2.2	21.0	2.9

\* Market Introduction

<sup>1</sup> No Treatment

<sup>2</sup> Corona Treatment

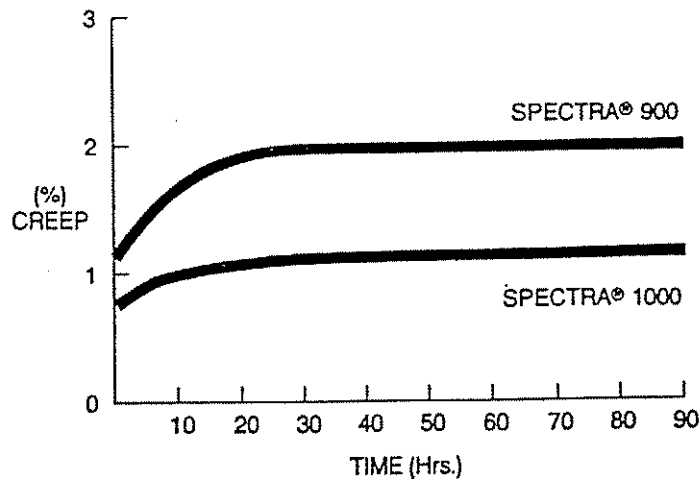
<sup>3</sup> Plasma Treatment

Figure 3. Chemical resistance.

Agent	% Strength Retention After 6 Months Immersion	
	SPECTRA 900	Aramid
Sea Water	100	100
10% Detergent solution	100	100
Hydraulic fluid	100	100
Kerosene	100	100
Gasoline	100	93
Toluene	100	72
Perchloroethylene	100	75
Glacial acetic acid	100	82
1M Hydrochloric acid	100	40
5M Sodium hydroxide	100	42
Ammonium hydroxide (29%)	100	70
Hypophosphite solution (10%)	100	79
Clorox®	91	0

Immersed in various chemical substances for a period of 6 months, SPECTRA fibers retained their original strength.

Figure 4. Creep at 10% load (room temperature).



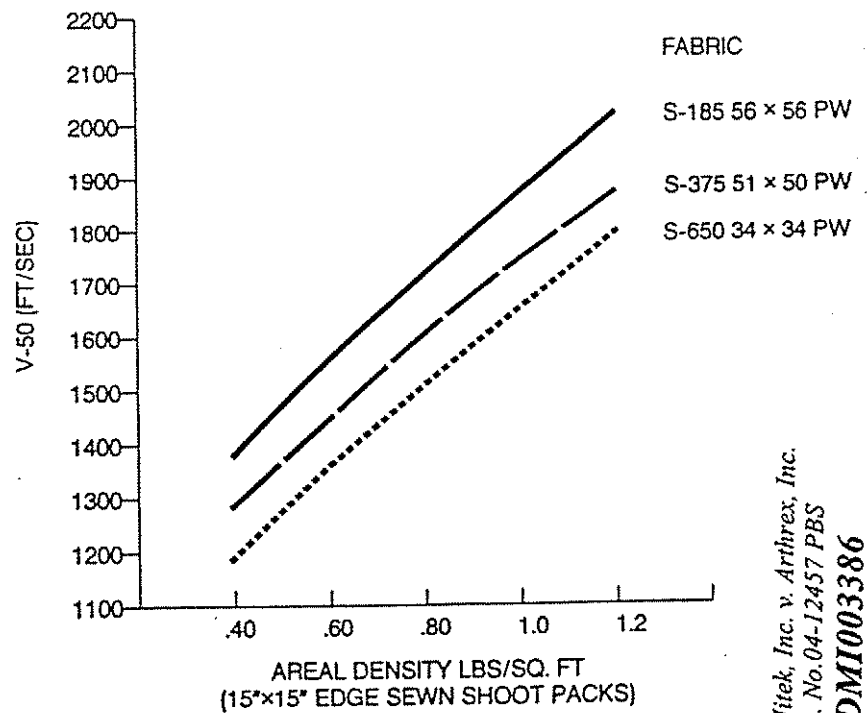
**TABLE 3**  
**COMPARATIVE PROPERTIES OF 16-STRAND ROPE**

Property	SPECTRA® 900	Aramid
Diameter (In)	0.088	0.10
Wt/100 Ft (Lb)	0.153	0.32
Tensile Strength (Lb)	1465	1334

**TABLE 4**  
**CYCLE LOADING AND WEAR TESTS**

	SPECTRA® 900	Aramid
Cyclic Sheave - 12 Strand Braid (10 Cycles/Min, 4000 Lb Tensile Load) Cycles to Break	10,231	1212
Oscillating Bar - 0.5 In. Rope (1.5 Cycles/Min, 1700 Lb Tensile Load) Cycles to Break	883	111

**Figure 5.** Ballistic performance of SPECTRA® fabrics.



.22 CAL 17 GR FSP

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**DMI003386**

Figure 6. Ballistic performance of Spectra® and Aramid composites.

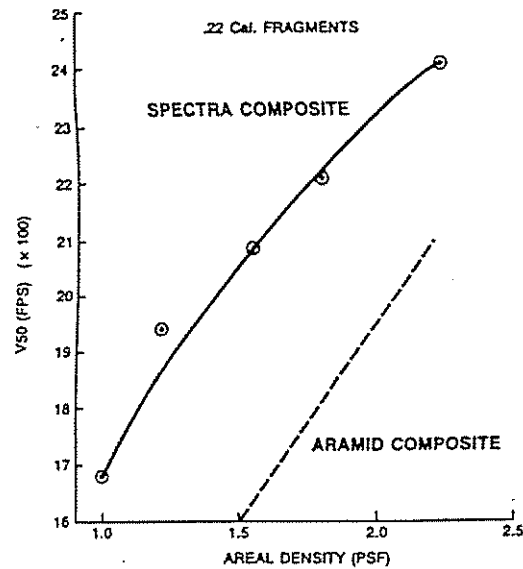


Figure 7. Spectra® fabric ballistic performance at elevated temperatures.

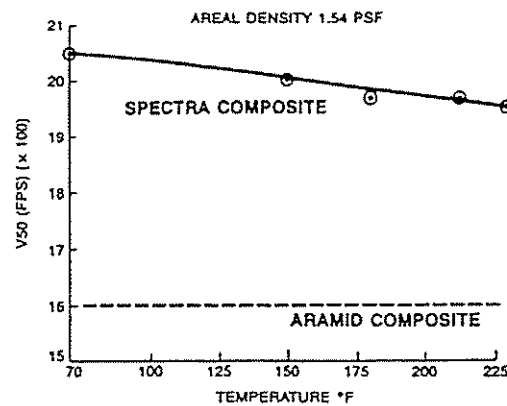
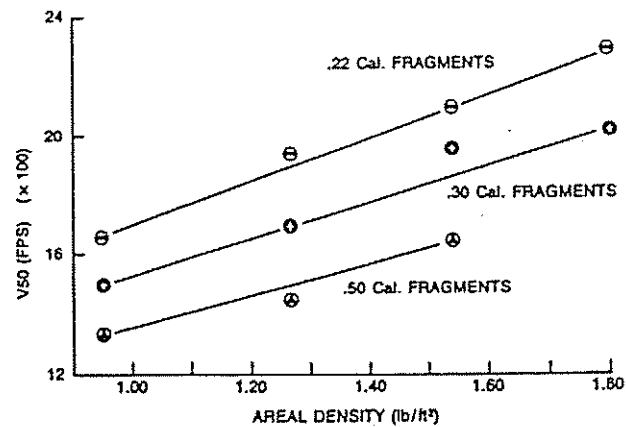


Figure 8. Spectra® composite ballistic protection versus .22, .30 & .50 caliber fragments.



**TABLE 5**  
**RESISTANCE TO HANDGUN AMMUNITION OF**  
**SPECTRA® AND ARAMID COMPOSITES**

Ammunition	No.	Armor System	AD (PSF)	V50 (FPS)
.357 Cal. 158 grain JSP	1	Spectra/Vinylester 411-45	0.62	1220
	2	Spectra/Vinylester 411-45	1.12	1443
	3	Kevlar/Polyester	1.15	1281
	4	Spectra/Vinylester 411-45	1.36	1481
	5	Kevlar/Polyester	1.49	1311
9mm 124 grain FMJ	6	Spectra/Vinylester 411-45	0.62	1082
	7	Spectra/Latex	0.70	1200
	8	Spectra/Vinylester 411-45	0.83	1173
	9	Spectra/Latex	1.01	1454
	10	Spectra/Latex	1.23	1594
	11	Kevlar/Polyester	1.28	1241
	12	Kevlar/Polyester	1.46	1372
	13	Spectra/Latex	1.53	1624

Products: Spectra 1000 and Kevlar 29

**TABLE 6**  
**INSTRUMENTED IMPACT OF FABRIC COMPOSITES**

Resin: Epoxy Resin

Fiber Vol. Loading: 60%

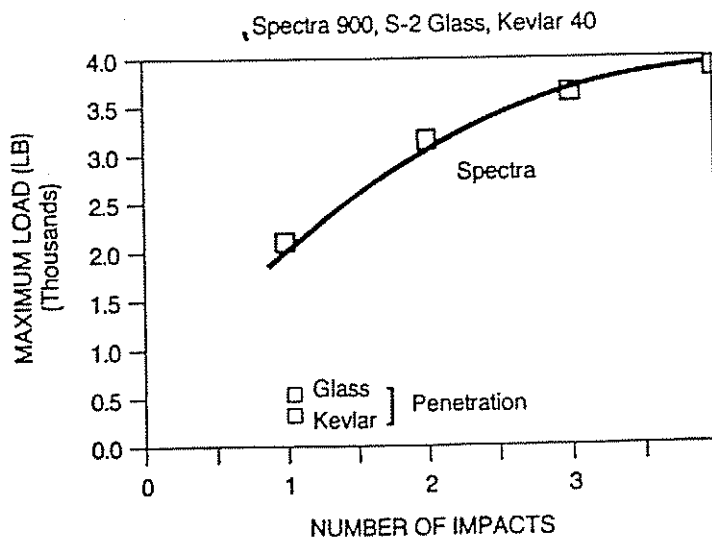
Fiber	Treatment	Max Load (Lb)	Energy At Max Load (Ft-Lb)	Total Energy (Ft-Lb)	Observation
SPECTRA 900	TN <sup>1</sup>	1660	47.4	54.5	No Penetration
SPECTRA 900	TP <sup>2</sup>	1030	12.0	28.0	Penetration
Kevlar 49	EC <sup>3</sup>	254	1.3	6.7	Penetration
S-2 Glass	EC	370	1.8	4.4	Penetration
HM Graphite	EC	133	1.2	2.5	Penetration

<sup>1</sup> No Treatment

<sup>2</sup> Plasma Treatment

<sup>3</sup> Epoxy Compatible

**Figure 9.** Repetitive impact of Spectra® composites.

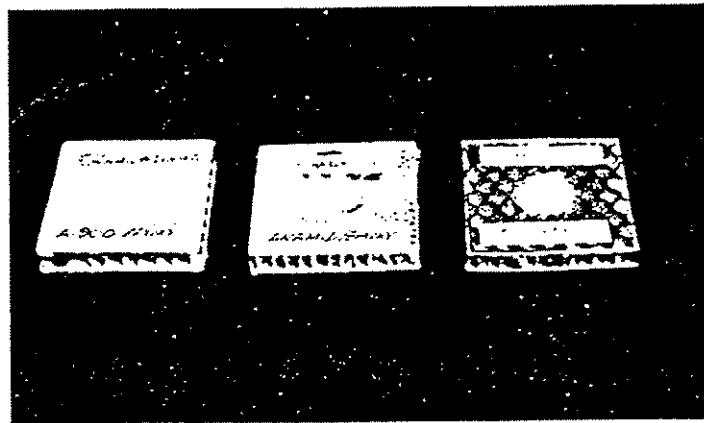


**TABLE 7**  
**IMPACT ABSORPTION OF SANDWICH COMPOSITES**

Core: ½ in. honeycomb (3 lb./cu. ft.)  
Resin: Epoxy (Epon 826)

Skin	No. of Layers	Energy to Peak Force (ft. lb.)	Total Energy Absorbed (ft. lb.)
SPECTRA 900	1	22.4	61.5
Aramid	1	0.7	2.3
SPECTRA 900	3	33.5	59.8
Aramid	3	1.5	10.5

Figure 10. Hailstorm test on Type A composite sandwich panels courtesy of Norton Company, Ravenna, OH.



**TABLE 8**  
**FIBER ELECTRICAL PROPERTIES**

Material	Dielectric Constant	Loss Tangent
SPECTRA	2.0-2.3	0.0002-0.0004
E-Glass	4.5-6.0	0.0060
Aramid	3.85	0.0100
Quartz	3.78	0.0001-0.0002

Figure 11. Transmission versus relative thickness for flat panels at 8.5 GHZ.

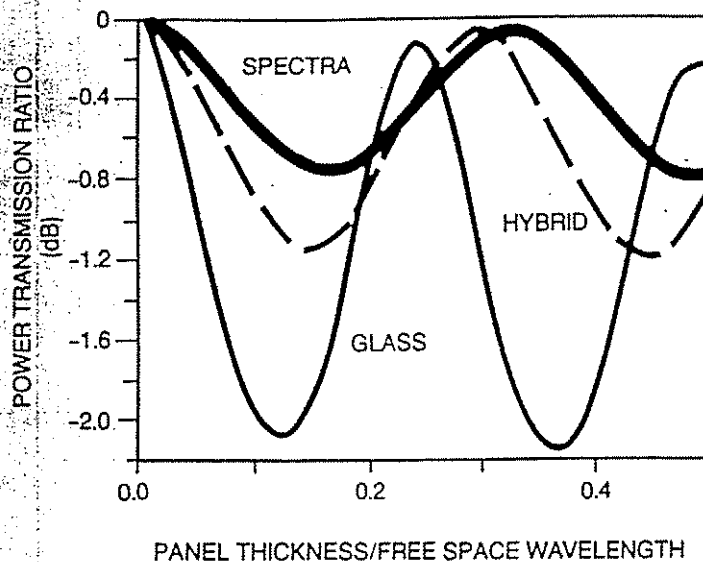


Figure 12. Transmission versus relative thickness Type A, sandwich radome test panel at 8.5 GHZ.

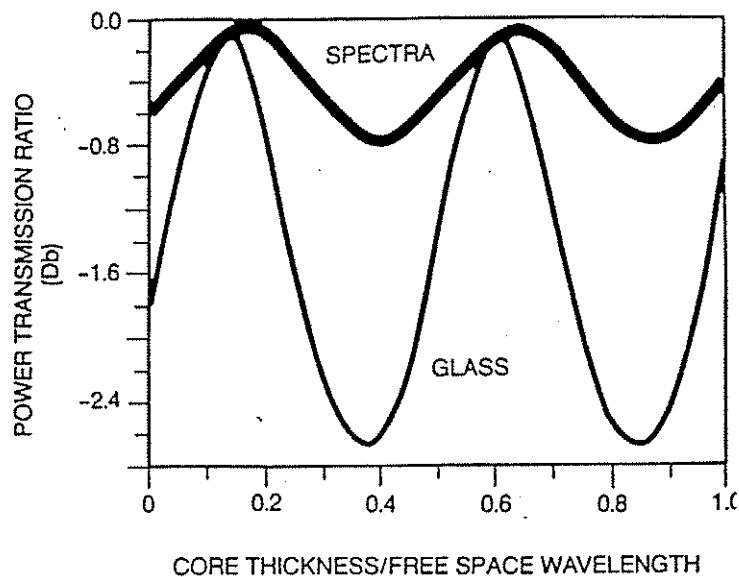


TABLE 9  
PROPERTIES OF UNIDIRECTIONAL COMPOSITES  
(NON TREATED FIBER)

	Spectra® 900	Spectra® 1000
Axial tensile strength ( $10^3$ psi)	174	217
Axial tensile modulus ( $10^6$ psi)	5.8	9.1
Axial strain to failure (%)	3.8	2.6
Major Poisson's Ratio	0.32	0.28
Transverse tensile strength ( $10^3$ psi)	1.4	1.5
Transverse tensile modulus ( $10^6$ psi)	0.6	0.2
Axial compressive strength ( $10^3$ psi)	15.8	16.0
Axial compressive modulus ( $10^6$ psi)	—	3.6
Short beam shear strength ( $10^3$ psi)	4.0	2.5

## Exhibit 2

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## Briefs and Other Related Documents

United States District Court, S.D. Illinois.  
William SPRINKLE, Plaintiff,  
v.  
LOWE'S HOME CENTERS, INC., Defendant.  
Civil No. 04-CV-4116-JPG.

July 19, 2006.

A. Courtney Cox, Hart & Hart, Benton, IL, for Plaintiff.

Amanda Helm Wright, Keith C. Hult, David L. Christlieb, Littler Mendelson, Chicago, IL, Thomas R. Peters, Gundlach, Lee et al., Belleville, IL, for Defendant.

**MEMORANDUM AND ORDER**

J. PHIL GILBERT, District Judge.

\*1 This matter comes before the Court on Defendant Lowe's Home Centers, Inc.'s (Lowe's) motion for summary judgment (Doc. 33). Plaintiff William Sprinkle (Sprinkle) has responded (Doc. 36) and Lowe's has replied (Doc. 38). Lowe's has also filed a motion to strike certain exhibits offered by Sprinkle (Doc. 37). Sprinkle has filed affidavits intended to authenticate the exhibits in question (Docs. 41 & 42). For the following reasons, the Court will deny both Lowe's motion to strike (Doc. 37), and Lowe's motion for summary judgment (Doc. 33).

**SUMMARY JUDGMENT STANDARD**

Summary judgment is proper where "the pleadings, depositions, answers to interrogatories, and admissions on file, together with the affidavits, if any, show that there is no genuine issue as to any material fact and that the moving party is entitled to judgment as a matter of law." Fed.R.Civ.P. 56(c); see *Celotex Corp. v. Catrett*, 477 U.S. 317, 322

(1986); *Spath v. Hayes Wheels Int'l-Ind., Inc.*, 211 F.3d 392, 396 (7th Cir.2000). The Court construes all facts in the light most favorable to the nonmoving party and draws all justifiable inferences in the nonmoving party's favor. *Anderson v. Liberty Lobby, Inc.*, 477 U.S. 242, 255 (1986); *Spath*, 211 F.3d at 396.

The moving party has the burden of establishing that there is no genuine issue of material fact. *Celotex Corp.*, 477 U.S. at 323. If it meets this burden, the nonmoving party must set forth facts that demonstrate the existence of a genuine issue of material fact. Fed.R.Civ.P. 56(e); *Celotex*, 477 U.S. at 322-26; *Johnson v. City of Fort Wayne*, 91 F.3d 922, 931 (7th Cir.1996). The nonmoving party must do more than cast "some metaphysical doubt as to the material facts," *Matsushita Elec. Indus. Co. v. Zenith Radio Corp.*, 475 U.S. 574, 586 (1986); *Michas v. Health Cost Controls of Ill., Inc.*, 209 F.3d 687, 692 (7th Cir.2000). Rather, the nonmoving party must demonstrate to the Court that the evidence is such that a reasonable jury could return a verdict in his favor. *Anderson*, 477 U.S. at 248; *Insolia v. Phillip Morris Inc.*, 216 F.3d 596 (7th Cir.2000). Mere assertions of a factual dispute unsupported by probative evidence will not prevent summary judgment. *Anderson*, 477 U.S. at 248-250.

**BACKGROUND****I. Motion to Strike (Doc. 37)**

As a preliminary matter, the Court must define what evidence it will consider when ruling on the motion for summary judgment. Lowe's has asked the Court to strike certain exhibits offered by Sprinkle on the grounds that they have not been properly authenticated. Sprinkle has filed two affidavits in an attempt to properly authenticate these documents. Anniethabatha M. Bond (Bond), a paralegal with Sprinkle's attorney, signed an affidavit attesting she

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received Exhibits D, E, F, M, O and P from Lowe's during the course of discovery. Sprinkle signed an affidavit attesting to personal knowledge as to the authenticity of Exhibit G.

\*2 The evidence a party relies upon to defeat a motion for summary judgment must be of a type that is admissible at trial. *Haywood v. Lucent Techs., Inc.*, 323 F.3d 524, 533 (7th Cir.2003). Therefore, for purposes of summary judgment, the Court may only consider properly authenticated documents as evidence. *Scott v. Edinburg*, 346 F.3d 752, 759-760 (7th Cir.2003).

"The requirement of authentication ... as a condition precedent to admissibility is satisfied by evidence sufficient to support a finding that the matter in question is what its proponent claims." Fed.R.Evid. 901(a). Generally speaking, the proponent of the proffered evidence need only make a *prima facie* showing that the exhibit is what the proponent claims it is. See *United States v. Kelly*, 14 F.3d 1169, 1175 (7th Cir.1994). Furthermore, circumstantial evidence is sufficient to establish the authenticity of a document. *United States v. Clark*, 649 F.2d 534, 542 (7th Cir.1981). The proponent may establish authenticity by showing that the "[a]pppearance, contents, substance, internal patterns, or other distinctive characteristics, taken in conjunction with circumstances" indicate that the evidence is what he purports it is. Fed.R.Evid. 901(b)(4). When a party has produced the document in question in response to a subpoena or discovery request, he has implicitly authenticated the document. *United States v. Laurence*, 934 F.2d 868, 871-72 (7th Cir.1991). Additionally, the Court may consider the internal contents of the document, particularly if the events alluded to in the documents are only known to a small group of people. Fed.R.Evid. 901(b)(4); *United States v. Smith*, 223 F.3d 554, 570 (7th Cir.2000).

#### A. Exhibit G

Exhibit G appears to be a copy of a decision handed down from the Appeals Division of the Illinois Department of Employment Security. The captioning, format and substance of the document

seem to be that of a decision issued from a state agency. Sprinkle has submitted an affidavit attesting that he has personal knowledge that the document is a true and correct copy of a document provided to him by the Illinois Department of Employment Security. This is sufficient for a *prima facie* showing of authenticity.

#### B. Exhibits E, F, O & P

Exhibits E, F, O and P were all produced by Lowe's during discovery, as attested by Bond. Additionally, they appear to be documents of a type kept by a business such as Lowe's. The appearance of these documents in conjunction with the highly probative fact that they were produced by Lowe's during discovery is sufficient to authenticate the documents for purposes of the summary judgment motion.

#### C. Exhibits D & M

Exhibits D and M are authenticated by the fact that they came from Lowe's pursuant to discovery combined with the fact that they discuss matters known only to a small group of people. Specifically, Exhibit D appears to be a handwritten note dated February 18, 2003, and signed by George Donoho (Donoho), manager of Lowe's Mount Vernon, Illinois store in which Donoho relates a conversation he had on that date with Sprinkle, terminating Sprinkle's employment. Exhibit M appears to be an email between Lowe's loss prevention personnel discussing allegations, presumably known to only a few people, that the Mount Vernon store had "padded sales." As attested by Bond, these documents came from Lowe's pursuant to discovery in this case. That, added to the subject matter of the notes, authenticates the documents for purposes of the summary judgment motion.

\*3 In conclusion, the affidavits provided by Sprinkle combined with the circumstances, substance, appearances and contents of the documents in question support a finding that the documents are what Sprinkle purports they are. Therefore, the Court will deny the motion to strike

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(Doc. 37), and may consider the documents for purposes of the summary judgment motion.

## II. Facts

Taken in the light most favorable to the non-moving party, the evidence establishes the following facts. Lowe's hired Sprinkle in March 2002 to be a commercial sales consultant for its Mount Vernon store, where he quickly became one of the top salesmen in his district. Because a commercial sales consultant sells building material and other Lowe's products to commercial contractors, Sprinkle's job often required that he work outside of the store. In fact, Sprinkle's immediate supervisor, Richard Lautenbacher (Lautenbacher) told Sprinkle he should hardly ever be in the store; instead he should be out getting sales.<sup>FN1</sup> Lowe's would reimburse Sprinkle for mileage when he traveled to and from customer's construction sites if he turned in an expense report. Lowe's written policies required that Sprinkle report all hours he worked for the company, and also forbid employees to work off-the-clock, drink alcohol during work hours, or issue false or misleading documents or reports. Additionally Lowe's expected all employees to "devote their full time to the Company's interest during regular hours of employment."

FN1. The Court will regard statements by all Lowe's employees acting in a managerial capacity as party admissions. Fed.R.Evid. 801(d)(2). This includes statements made by Winn, Hornbeak, Donoho, Switzer and Lautenbacher.

Sprinkle had read and was aware of Lowe's written policies. However, during the course of his employment, Mount Vernon store manager Phil Hornbeak (Hornbeak) told Sprinkle to disregard some of those policies. Specifically, Hornbeak told Sprinkle, in the presence of Lautenbacher, to do blueprint "takeoffs" <sup>FN2</sup> from his home, because customers often interrupted Sprinkle during takeoffs at the store. Hornbeak also told Sprinkle to take potential customers out for meals and drinks in order to get them to place their orders with Lowe's,

adding that it was fine if Sprinkle had a drink with customers, but he should avoid returning to the store that day. Additionally, when Sprinkle expressed his concern to Hornbeak about his ability to remember correct dates for expense reports, Hornbeak told him not to worry about correct dates, just approximate mileage.

FN2. A takeoff is a practice whereby a customer gives a Lowe's employee a blueprint from which the employee determines the amount and cost of necessary building materials.

Hornbeak also told Sprinkle about a practice called "bogus sales," which could be used to give store managers a temporary boost in sales numbers. "Bogus sales" are a subset of "committed sales," a common practice in the industry, which allows sales specialists to hold items at a certain price for a customer by placing the cost of the items on the customer's account. A Lowe's employee running a bogus sale would run committed sales on items that had not been authorized by customers. Hornbeak told Sprinkle that Lowe's employees would run bogus sales during weeks when a store's sales were bad and would reverse them when sales were good. The customer would never see the charges, and no harm would be done. Hornbeak's supervisor Dennis Winn (Winn) had participated in bogus sales when Winn was a Lowe's store manager and continued to condone the practice. Loretta Switzer (Switzer), a supervisor in another department, told Sprinkle that bogus sales had been going on for years.

\*4 Hornbeak asked both Sprinkle and commercial sales specialist J.D. Cross (Cross) to run bogus sales for him, but both refused. However, Cross believed that others had run bogus sales under his unique employee number without his knowledge. Sprinkle informed Hornbeak and other Lowe's employees that he had spoken with his lawyer, and that he believed running bogus sales was illegal and he would not participate in them. Not long after, Winn told other Lowe's managers that he was looking for an excuse to fire Sprinkle. In August 2002, Hornbeak gave Sprinkle a written "initial notice" for violating Lowe's policy by writing down another

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associate's price override code.

In November 2002, Hornbeak transferred to Lowe's Carbondale, Illinois store and Donoho replaced him as store manager at the Mount Vernon store. Sprinkle continued to follow the same practices he had followed under Hornbeak regarding doing blueprint takeoffs at home, taking contractors out for meals and drinks, and paying little attention to the dates on expense reports for mileage reimbursements. Shortly after Donoho's arrival at the Mount Vernon store, Sprinkle went behind the customer service desk. When an assistant store manager informed Sprinkle that he was violating store policy by being there, Sprinkle became verbally abusive. In response, Donoho gave Sprinkle a written "final notice" for insubordination, warning him that future instances of insubordination could result in termination.

In early 2003, Donoho became suspicious of how Sprinkle was spending his time outside of the store. Donoho asked loss prevention specialist Alex Rusher (Rusher) to follow Sprinkle to ensure that Sprinkle followed Lowe's policies when he worked outside of the store. On January 24, Rusher and fellow loss prevention specialist Terri Gerton (Gerton) followed Sprinkle to his home where he stayed for an hour and a half, then followed him back to the store. Sprinkle knew about the surveillance and complained to Donoho that he found it degrading. He told Donoho that Gerton and Rusher had followed him to his house where he had gone to do blueprint takeoffs. Donoho told Sprinkle not to worry about the surveillance and to keep on doing what he had been doing. On February 3, Sprinkle sent Donoho an email complaining that he felt Donoho did not trust him. He told Donoho that he sometimes visited his family or friends while on-the-clock, but made up for it by working on behalf of Lowe's off-the-clock, for instance by taking contractors out to breakfast or having them over for dinner.

Later that month, Sprinkle turned in an expense report for mileage reimbursement for a trip to Bonnie, Illinois which he erroneously claimed he had taken on January 24. On February 18, loss prevention manager Steve Meadows (Meadows)

and Rusher confronted Sprinkle with the erroneous expense report. Sprinkle admitted he did not record his mileage daily, and sometimes made mistakes as to the exact number of miles traveled or the exact dates of travel. During the course of the interview with Rusher and Meadows, Sprinkle reiterated what he had said in his email to Donoho: that he sometimes took breaks while on-the-clock, but made up for it by working off-the-clock.

\*5 At the conclusion of the interview, Donoho entered the room and, with prior approval from Winn, told Sprinkle that he was being fired for violations of Lowe's policies. Sprinkle filed for unemployment insurance benefits which, upon appeal, were granted.<sup>FN3</sup> Sprinkle then brought suit against Lowe's charging that he was wrongfully fired in retaliation for refusing to take part in bogus sales.<sup>FN4</sup>

FN3. Sprinkle presented the findings of fact from the Illinois Department of Employment Security Appeals Division as evidence to support his claim that Lowe's at one time asserted they fired Sprinkle for taking contractors out for breakfast. However, because Lowe's did not appear for the hearing at which the findings of fact were determined, the Court cannot infer that Lowe's ever made such an assertion.

FN4. Sprinkle also alleged that he was fired for making a statement in favor of an African-American co-worker, Lylie "Buddy" Martin, who was suing Lowe's for racial discrimination. However, to the extent that Sprinkle alleges Lowe's conduct is in violation of Illinois state law, any such claim is preempted by the Illinois Human Rights Act, 775 ILCS 5/1-101 *et seq.*, and Illinois state courts (and federal courts sitting in their stead) lack jurisdiction over such claims, which proceed instead in front of the Illinois Human Rights Commission. *See Mein v. Masonite Corp.*, 485 N.E.2d 312, 315 (Ill.1985). To the extent that Sprinkle alleges Lowe's conduct violates Title VII, he has failed to state a cause of

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action because he has not shown that he exhausted his administrative remedies. *See Rush v. McDonald's Corp.*, 966 F.2d 1104, 1110 (7th Cir.1992).

## ANALYSIS

### I. Retaliatory Discharge

Because this case is a diversity action, the Court must follow the common law of Illinois. *Erie R.R. v. Tompkins*, 304 U.S. 64 (1938). In Illinois, an employer may discharge an at-will employee, such as Sprinkle, for any reason or for no reason at all. *Pratt v. Caterpillar Tractor Co.*, 500 N.E.2d 1001, 1002 (Ill.1986). One exception to that rule is the tort of retaliatory discharge. *Brandon v. Anesthesia & Pain Mgmt. Assocs., Ltd.*, 277 F.3d 936, 940-41 (7th Cir.2002). The Illinois Whistleblower Act (Act) is the codification of this common law. *Sutherland v. Norfolk Southern Ry. Co.*, 826 N.E.2d 1021, 1025 n. 4 (Ill.App.Ct.2005). The common law test for retaliatory discharge often focused parties' attention on whether the plaintiff was able to articulate a "clearly mandated public policy." *Pratt*, 500 N.E.2d at 1002; *Palmateer v. Int'l Harvester Co.*, 421 N.E.2d 876 (Ill.1981). However, Illinois courts have established that the "clear mandate of public policy" standard is met when an employee is fired for refusing to engage in illegal activity or for reporting the illegal conduct of others, and the Act codifies this reasoning as well. *Palmateer* 421 N.E.2d at 879; *Stebbins v. Univ. of Chicago*, 726 N.E.2d 1136, 1144. The Act provides that "[a]n employer may not retaliate against an employee for refusing to participate in an activity that would result in a violation of a State or federal law, rule or regulation." 740 ILCS 174/20 (2004). Illinois law does not require that the activity in question actually be against the law, only that the employee had a good faith reasonable belief that it was. *Stebbins*, 726 N.E.2d at 1144.

The employer must actually discharge the employee in order for the employee to state a claim under the Act, as Illinois courts have consistently refused to expand the tort of retaliatory discharge to encompass adverse employment actions short of

actual discharge. *See Barr v. Kelso-Burnett Co.*, 478 N.E.2d 1354, 1356 (Ill.1985) (finding the Illinois Supreme Court does not "strongly support" the expansion of the tort); *Hartlein v. Illinois Power Co.*, 601 N.E.2d 720, 730 (Ill.1992) (refusing to expand the tort of retaliatory discharge to encompass constructive discharge). Therefore, in order to succeed on a retaliatory discharge claim under the Act, the plaintiff must prove that 1) he was discharged from his employment, and 2) his discharge was in retaliation for his refusal to participate in an activity that he reasonably believed would result in a violation of a State or federal law, rule or regulation. Because Lowe's admits that it discharged Sprinkle, the Court's focus will be on whether Sprinkle has shown that Lowe's discharged him in retaliation for taking part in a protected activity.

### II. Framework for Showing Retaliation

\*6 The Court may analyze an Illinois retaliatory discharge case using the burden-shifting *McDonnell-Douglas* framework, *Carter v. Tennant Co.*, 383 F.3d 673, 677-78 (7th Cir.2004), despite the concerns of the Illinois Supreme Court that such a framework improperly reduces the plaintiff's burden of proving all the elements of the tort. *Clemons v. Mech. Devices Co.*, 704 N.E.2d 403, 407-08 (Ill.1998). To establish a *prima facie* case for retaliatory discharge in violation of the Act under the *McDonnell-Douglas* framework, Sprinkle must show: 1) that he engaged in a protected activity; 2) that he was performing his job satisfactorily and was nevertheless fired, and 3) that others who did not engage in the protected activity were treated more favorably than he was. *Carter*, 383 F.3d at 678. If Sprinkle makes out a *prima facie* case, the burden shifts to Lowe's to articulate a legitimate, non-discriminatory reason for his termination. *Id.* If Lowe's presents such a reason, the burden then shifts back to Sprinkle to show that Lowe's proffered reason is nothing more than a pretext for unlawful discrimination. *Id.* If the employee does not refute a valid reason given by the employer for his termination, he cannot prevail. *Carter*, 383 F.3d at 678.

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*A. Sprinkle Engaged in Protected Activity About Which Lowe's May Have Known*

Sprinkle meets the first prong of the *McDonnell-Douglas* test because he refused to participate in a practice he reasonably believed to be illegal. Sprinkle suspected that bogus sales were illegal, and consulted a lawyer to confirm his suspicions. Then he informed Lowe's that he believed bogus sales were illegal and refused to take part in them. Therefore, Sprinkle can show that his belief was reasonable and held in good faith. Accordingly, his refusal to engage in bogus sales constituted a protected activity.

Additionally, a jury could reasonably find that Lowe's was aware Sprinkle had engaged in protected activities when it fired him. Lowe's argues that Donoho made the decision to fire Sprinkle, and that Donoho was unaware that Sprinkle had engaged in a protected activity. However, a jury could reasonably infer that Winn actually made the decision to fire Sprinkle because Donoho did not have the authority to fire Sprinkle without Winn's approval. A jury could also reasonably conclude that Winn was aware that Sprinkle engaged in protected activities because many of the Mount Vernon employees knew and communicated regularly with Winn. Therefore, a reasonable jury may conclude that Sprinkle meets the first element of his *prima facie* case. Sprinkle may also meet the other elements of a *prima facie* case for retaliatory discharge.

*B. Sprinkle May Have Been Performing Satisfactorily When He Was Fired*

Sprinkle has presented evidence from which a reasonable jury could conclude that he was performing satisfactorily when he was discharged. While under surveillance by Lowe's, Sprinkle violated some of Lowe's written policies, and later admitted to the violations in his email to Donoho and in his interview with Rusher and Meadows. However Hornbeak, in Lautenbacher's presence, told Sprinkle he could disregard some of Lowe's policies. While Hornbeak was no longer the Mount Vernon store manager, Lautenbacher was still

Sprinkle's immediate supervisor so a jury could find that Lowe's expectations of Sprinkle had not changed. Additionally, although he had some disciplinary infractions on his employment record, Sprinkle was one of his district's top sales consultants. In light of this, a jury could reasonably conclude that Sprinkle was performing his job to Lowe's satisfaction, but Lowe's fired him anyway. Therefore, Sprinkle has shown that there is a genuine issue of material fact as to whether he was performing his job satisfactorily when he was discharged. Accordingly, if Sprinkle can show that similarly situated employees who ran bogus sales were treated more favorably than he was, he can make a *prima facie* case under the *McDonnell-Douglas* framework for retaliatory discharge.

*C. Lowe's May Have Treated Similarly Situated Employees Who Did Not Engage in Protected Activities More Favorably*

\*7 Sprinkle has presented sufficient evidence from which a reasonable jury could conclude that Lowe's gave more favorable treatment to its employees who did agree to run bogus sales. A jury could reasonably conclude that Sprinkle was allowed to violate Lowe's policies prior to notifying Hornbeak that he would not run bogus sales, but was fired for the same behavior after his refusal to run bogus sales. Therefore, a jury could conclude that Sprinkle was fired by Lowe's for violating policies that an employee who agreed to run bogus sales would have been permitted to violate. As such, there is a genuine issue of material fact as to whether Lowe's treated similarly situated employees who ran bogus sales more favorably than those who did not. In conclusion, a jury may reasonably find that Sprinkle has made a *prima facie* case for retaliatory discharge.

*D. Lowe's Articulated Reasons for Firing Sprinkle May Be Pretext for Retaliation*

In addition to finding that Sprinkle has proved a *prima facie* case for retaliatory discharge, a reasonable jury could conclude that Lowe's stated

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reasons for terminating Sprinkle's employment are pretextual. Lowe's fired Sprinkle after it had placed him under surveillance and gathered proof that he was violating company policies. However, a jury could conclude that absent a retaliatory motive, Lowe's would not have fired an employee for violating those company policies. Accordingly, a reasonable jury could find that Lowe's stated reasons for discharging Sprinkle are merely pretext for retaliation.

END OF DOCUMENT

In conclusion, the Court finds that there is evidence from which a reasonable jury could return a verdict in favor of Sprinkle. Therefore, summary judgment is inappropriate at this time.

### CONCLUSION

For the forgoing reasons, the Court **DENIES** Defendant's Motion to Strike (Doc. 37), and **DENIES** Defendant's Motion for Summary Judgment (Doc. 33).

### IT IS SO ORDERED.

S.D.Ill.,2006.  
Sprinkle v. Lowe's Home Centers, Inc.  
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Briefs and Other Related Documents (Back to top)

- 2006 WL 1831623 (Trial Motion, Memorandum and Affidavit) Memorandum of Plaintiff in Opposition to Motion for Summary Judgment (May 18, 2006) Original Image of this Document with Appendix (PDF)
- 2006 WL 1468755 (Trial Motion, Memorandum and Affidavit) Defendant's Memorandum in Support of its Motion for Summary Judgment (Apr. 18, 2006) Original Image of this Document (PDF)
- 2004 WL 3099673 (Trial Pleading) Defendant's Answer and Affirmative Defenses (Aug. 12, 2004) Original Image of this Document (PDF)
- 2004 WL 3099669 (Trial Pleading) Complaint and Jury Demand (Jul. 7, 2004) Original Image of this Document (PDF)
- 4:04cv04116 (Docket) (Jul. 7, 2004)

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## **Exhibit 3**

IN THE UNITED STATES DISTRICT COURT  
FOR THE DISTRICT OF MASSACHUSETTS

DePuy Mitek, Inc.	)	
a Massachusetts Corporation	)	
	)	
Plaintiff,	)	
	)	
v.	)	Civil Action No. 04-12457 PBS
	)	
Arthrex, Inc., <i>et al.</i>	)	
a Delaware Corporation	)	
	)	
Defendant.	)	
	)	

**DECLARATION OF DR. DEBI PRASAD MUKHERJEE IN SUPPORT OF  
DEFENDANTS' OPPOSITION TO PLAINTIFF DEPUY MITEK'S MOTION TO  
STRIKE HEARSAY EXHIBIT AND ALL CITATION AND COMMENTARY THERETO**

1. My name is Dr. Debi Prasad Mukherjee. I am an Associate Professor and the Coordinator of Bioengineering in the Department of Orthopaedic Surgery at the Louisiana State University Health Sciences Center, in Shreveport, Louisiana. My CV is attached as Ex. A.
2. I am the same Dr. Debi Prasad Mukherjee who prepared the "Expert Report of Dr. Debi Prasad Mukherjee Concerning Invalidity of U.S. Patent No. 5,314,446" dated March 3, 2006, the "Responsive Expert Report of Dr. Debi Prasad Mukherjee Concerning Non-Infringement of U.S. Patent No. 5,314,446 and Other Matters" dated March 24, 2006, and the "Rebuttal Expert Report of Dr. Debi Prasad Mukherjee" dated April 13, 2006.
3. I understand that Spectra is a known trade name for UHMWPE and that manufacturers' brochures such as the brochure published by Allied Fibers Technical Center entitled "SPECTRA EXTENDED CHAIN POLYETHYLENE FIBERS" (Ex. B) ("the SPECTRA brochure") are the best sources of information since the manufacturers of these types of products are in the best

position to provide accurate descriptions of their product, the history of their product development and a comparison to related products.

4. The Spectra brochure supports the opinions I provided in this case regarding the differences between general purpose PE and UHMWPE, including my opinion that in 1992, UHMWPE was a well-known, highly specialized fiber material with strength properties that are far superior to that of general purpose PE.

5. I have reviewed sections 1 & 2 of the Spectra brochure and, as described below, it is my opinion that the subject matter included in those sections is reliable and accurate.

6. Specifically, it is my opinion that the SPECTRA brochure is reliable and accurate in stating that UHMWPE is one of the strongest synthetic fibers ever created. Ex. B at § 1. *See, e.g.,* Ex. C at 5-26.

7. It is also my opinion that the SPECTRA brochure is reliable and accurate in stating that general purpose polyethylene has been used in industry for decades and has established itself as a general purpose commodity polymer. Ex. B at § 1.

8. It is further my opinion that the SPECTRA brochure is reliable and accurate in stating that since its introduction in fiber form in the 1980s, UHMWPE, has been considered a specialized high performance product. Ex. B at § 1. *See, e.g.,* Ex. D at 4.

9. It is my opinion that the SPECTRA brochure is reliable and accurate in stating that the key structural characteristics – molecular weight and molecular structure – of UHMWPE are very different than that of general purpose PE. Ex. B at § 2. *See, e.g.,* Ex. D at 4.

10. It is further my opinion that the SPECTRA brochure is reliable and accurate in stating that UHMWPE has a molecular weight in the range of approximately 1 to 5 million, whereas general purpose PE has a molecular weight of typically 50,000 up to several hundred thousand. Ex. B at § 2. *See, e.g.,* Ex. D at 4.

11. It is also my opinion that the SPECTRA brochure is reliable and accurate in stating that UHMWPE exhibits a much higher degree of crystalline orientation as compared with general purpose PE and that those differences in molecular structure are the basis for UHMWPE's superior strength characteristics. Ex. B at § 2. Ex. D at 4, 6.

I hereby declare under penalty of perjury that the foregoing is true and correct.

Executed on: Sept 15, 2006

Debi Prasad Mukherjee

Dr. Debi Prasad Mukherjee

# EXHIBIT A

## CURRICULUM VITAE

**Name**

Debi Prasad Mukherjee, Sc.D.

**Title**

Associate Professor and Coordinator of Bioengineering  
Department of Orthopaedic Surgery  
Louisiana State University Health Sciences Center

**Address**

1501 Kings Highway, P.O. Box 33932  
Shreveport, Louisiana 71130

**Telephone:** (318) 675-6187

**Fax:** (318) 675-6186

**Date of Birth**

October 26, 1939

**Family**

**Wife:** Bandana

**Sons:** Avik  
Shomik

**Education**

1961 B.Ch.E. (Hons), Chemical Engineering, Jadavpur  
University  
1965 S.M., Biochemical Engineering, M.I.T.  
1965 S.M., Chemical Engineering, M.I.T.  
1967 Ch.E., Chemical Engineering, M.I.T.  
1969 Sc.D., Chemical Engineering, M.I.T.  
1980 M.B.A., Business Administration, University of  
Connecticut

**Employment History**

1992-Present Associate Professor and Coordinator of Bioengineering  
Louisiana State University Health Sciences Center, Shreveport, Louisiana

1991-1992 Development Scientist  
Union Carbide, Bound Brook, New Jersey

1987 - 1990 Research Program Manager  
Dow Corning Wright, Arlington, Tennessee

1974 - 1987 Technical Specialist, Biomaterials  
Group Leader, Extrusion & Materials Development  
Senior Research Engineer

Davis & Geck, American Cyanamid Company, Danbury, Connecticut

1969 - 1974 Senior Research Engineer  
The Goodyear Tire & Rubber Company, Akron, Ohio

#### Academic Appointment

1989 - 1993 Adjunct Associate Professor, Biomedical Engineering  
Memphis State University, Memphis, Tennessee

1992 - Present Adjunct Associate Professor, Biomedical Engineering  
Louisiana Tech, Ruston, LA.

#### Thesis Supervised

1. M.S. Thesis (1992) by J. D. Ray Jr. "A Comparison of Fatigue Behavior for APC-2/AS4 and Commingled PEEK/AS-4 Composite", Dept. of Biomedical Engineering, Memphis State University, Memphis, TN.
2. M.S. Thesis (1992) by R. R. Shults, "A Characterization Study of Hydroxylapatite Coatings on Titanium Alloy Implant Material Before and After Fatigue", Dept. of Biomedical Engineering, Memphis State University, Memphis, TN.
3. M.S. Thesis (1993) by H. A. Mansour, "Bone/Prosthesis Relative Rigidity as an Important Parameter in the Isoelasticity of Total Hip Arthroplasty of the Human Proximal Femur", Department of Biomedical Engineering, Memphis State University, Memphis, TN.
4. M.S. Thesis (1994) by P. R. Menon, "Composites of Hydroxylapatite with Water Soluble or Biodegradable Polymers as a Synthetic Bone Graft Material", Louisiana Tech University, Ruston, LA.
5. M.S. Thesis (1996), by S. Ashroff, "Effect of Crystallinity of Hydroxyapatite Coating on Titanium Implants After Cyclic Fatigue Loading", Louisiana Tech University, Ruston, LA.
6. M.S. Thesis (1996), by N.R. Dorairaj, "Effects of Cyclic Fatigue Loading on the Stability of Hydroxyapatite Coated Titanium Dental Implants in the Presence of the Periodontal Pathogens", Louisiana Tech University, Ruston, LA.
7. M.S. Thesis (1999) by J.R. Hunter, "The measurement of Stress shielding and Relative Rigidity Mismatch within the femur prosthesis union of Total Hip Replacement" Louisiana Tech University, Ruston, LA.
8. Ph.D. Thesis (2001) by Kelly Crittenden, "Evaluation of 135- and 150-degree

Sliding hip screws". Louisiana Tech University, Ruston, LA.

### **Honors and Awards**

1. MNC Memorial Medal for securing the highest grade in the Sophomore Class of the Chemical Engineering Department, 1958.
2. E.F Berkman, RN Kruse, DP Mukherjee, KK Sadasivan, and JA Albright: A study of burst fracture in a canine model, Louisiana Orthopaedic Association, Harry Morris Award, 1993.
3. JW Sikes, BR Smith, DP Mukherjee, and KA Coward: "Comparison of Fixation of Locking Head and Conventional Screws in Fracture and Reconstruction Models." Winner of American College of Oral and Maxillofacial Surgeons Resident Research Award 18th Annual Meeting, San Diego, CA., 1997.
4. JW Sikes, BR Smith, and DP Mukherjee: "Effect of Bony Buttressing in the Atrophic Edentulous Mandible: An In Vitro Study." Winner of ITI Straumann Research Award, AAOMS 80th Annual Meeting, September 1998.
5. R Bhati, DP Mukherjee, KJ McCarthy, S Rogers, and DF Smith: "The Effect of Fibronectin Coating on the growth of Chondrocytes into a Biodegradable Scaffold." National Student Research Forum- The University of Texas Medical Branch of Galveston Texas, Department of Orthopaedic and Rehabilitation Award, 2000.

### **Editorial Board**

Journal of Long Term Effect of Medical Implants  
(Member of Editorial Advisory Board) 1998- Present

Journal of Biomedical Materials Research (Applied Biomaterials)  
(Member of Editorial Board) 1998-2002.

### **Conferences Organized**

Akron Polymer Lecture Group

Secretary, 1972  
Program Chairman, 1973

14th Southern Biomedical Engineering Conference

Chairman  
April 7-9, 1995, Shreveport, LA

### **Technical Sessions Chaired**

#### Biomaterials:

11th Southern Biomedical Engineering, Memphis, TN (1992), Session Chairman

#### Determination of Bone Properties:

12th Southern Biomedical Engineering, New Orleans, LA (1993), Session Chairman

#### Biomechanics and Biomedical Engineering Symposium

Orthopaedics Biomechanics I: 31st Annual Technical Meeting of the Society of Engineering Science, Texas A&M (1994) Session Co-Chairman

#### Orthopaedic Biomechanics

13th Southern Biomedical Engineering, Washington, D.C. (1994)- Session Chairman

#### Dental Materials: natural dentition polymers and composites

Sixth World Biomaterials Congress, Hawaii ( 2000) Session Co-moderator

Polymers in Orthopaedics Symposium (American Chemical Society) August 2002

Chaired the session

### **Public/Community Service Activities**

#### NIH Proposal Evaluations and Site Visits:

1. Reviewed the contracts on the bioerodible drug-delivery systems and was invited to a site visit to SRI on May 5-7, 1987, by the Contraceptive Development Branch, Center for Population Research, National Institutes of Health and Human Development - NIH contract, Dr. Dinesh Sharma.
2. Reviewed a number of proposal on drug-delivery systems and was invited for a working group in Bethesda, Maryland, on April 27, 1990, NIH contacts, Dr. H. Khan and Dr. D. Sharma.

3. Reviewed proposals on "Development and Testing of New Spermicides for National Institute of Child Health and Development", Bethesda, MD. June 16-17, 1992, NIH contact, Dr. S. Strenfert.
4. Special Study Section - Small Business Innovation Research (SBIR) Program, Rockville, MD, July 6-8, 1994, NIH contact, Dr. N. Vydelingum.
5. Task Group Chair, Scaffold Biomaterials Section, American Society of Testing and Materials (ASTM) 1998- 2001

#### **Institute Activities**

- 1992 - Present     Mentor ;Minority High School Student Research Apprentice Program
- 1992 - Present     Mentor: Summer Medical Student Research Program
- 1994 - 1995        Member of the Medical Communication Committee
- 1998-at present    Mentor: Science Medicine Academic Research Training Program
- 2001- Present      Flag Group Leader: Module III-New curriculum of instructions to Freshman/Sophomore Medical Students
- 2003-Present      Member of Institutional Review Board

#### **Invited Lecturer:**

Baylor College of Medicine, Department of Orthopaedic Surgery, -Grand Round – Plaster of Paris as a vehicle for delivery of tobramycin to treat Osteomyelitis, March, 13, 1994

Biomaterials Seminar in Atlanta: Technomic Publishing Co. Inc.  
Tissue Engineering Applications of Bioabsorbable Polymers, November 16, 1999

Baylor College of Medicine, Department of Orthopaedic Surgery, - Grand Round Baylor University Medical center, Houston, TX, Meniscal Repair, May 7, 2003

#### **Society Membership**

Orthopaedic Research Society  
Society for Biomaterials  
American Association of Advancement of Science

#### **Research Support and Meeting Grants**

1. American Heart Association, Akron Chapter, December 10, 1973, for the project, The Relationship of Dynamic Mechanical Properties of Arteriosclerotic Tissue to the Deposit of Cholesterol and Its Ester, jointly with Dr. Thomas Pynadath of Kent State University, Kent, Ohio 44242, \$8030.00
2. School of Dentistry, LSU Medical Center, and New Orleans. "Biomechanical In Vitro testing of the stability of HA coating etc.", jointly with Dr. J. Wittenberg, Department of Surgery, Division of Oral and Maxillofacial Surgery LSUMC-S, 1993, \$7500.00.
3. ExacTech Inc., Gainesville, FL. "Experimental testing of components comprising the ExacTech 913 Knee System." 1993, \$150.00
4. Whitaker Foundation: Fourteenth Southern Biomedical Engineering Conference, 1994, \$6,000.00.
5. Smith & Nephew Richards: Fourteenth Southern Biomedical Engineering Conference, 1994, \$1,000.00.
6. Sofamor Danek Medical: Fourteenth Southern Biomedical Engineering Conference, 1994, \$300.00.
7. Dean - LSU School of Medicine-Shreveport: Fourteenth Southern Biomedical Engineering Conference, 1994, \$4,500.00.
8. Center of Excellence for Arthritis & Rheumatology: 1992-1994, \$37,070.00
9. Ortho-Care, Inc: 1994, \$550.00.
10. Chitogenics, Inc.: Nov. 1995-May 1996, Evaluation of the carboxymethyl chitosan (NOCC) and hydroxyapatite composite paste for repairing bone defects in a rat model. Feasibility of using NOCC to complex with the hyaluronic acid to reduce the drop of viscosity of synovial fluids of the rheumatoid patients. \$10,000.00.
11. Intramural Grant: January 1, 1997 - December 31, 1997. Tissue Engineering - Development of Scaffolds seeded with Different Cell types on a biodegradable matrix. \$5,000.00.
12. Wright Medical Technology: June 15, 1997 - Feb. 1999. Measurement of Creep Properties of Bone Cement. \$15,000.00
13. Louisiana Board of Regents: Travel Grant for Emerging Faculty. \$500.00.
14. Celanese Acetate: November, 15, 1998- November 15, 1999. Feasibility study of modification of cellulose acetate filters (CAF) by gamma and electron beam radiations. \$7,060.00.

15. Board of Regents Support fund, June 2000-June 2001 with matching grant from LSUHSC: Replacement of Biaxial Testing machine (Instron Model 1321) by a new digital biaxial machine (Model 8874): **\$117,732.**
16. Clinical and Industrial technology Company, July 2000- July 2001: A New Vibration Mixer for Bone Cement: **\$14,000.**
17. Department of Obstetrics & Gynecology , 2002-2003: "Biomechanical Studies on several Sutures". **\$3420.**
18. W.L.Gore and Associates, Biodegradable Scaffold for Tissue Engineering , Jan -May 2004, **\$5000.**

**PUBLICATIONS****Research Thesis**

D. P. Mukherjee, The Viscoelastic Properties of Elastin, Sc.D.  
Thesis in the Department of Chemical Engineering, M.I.T.,  
January 13 (1969).

**Papers and Abstracts of Presentations**

1. DP Mukherjee and A.S. Hoffman: The Viscoelastic Properties of Elastin. Presented at the Third Biophysics Congress, August (1969).
2. A.S. Hoffman and DP Mukherjee: long-range Interactions of Cationic Sites in Elastin. Presented at the Conference on Engineering in Medicine and Biology, October 31(1971).
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# EXHIBIT B

15

EXTENDED-CHAIN FIBER

**SPECTRA®**  
**EXTENDED CHAIN**  
**POLYETHYLENE FIBERS**

*DePuy Mitek, Inc. v. Arthrex, Inc.*  
*C.A. No.04-12457 PBS*  
*DMI003378*

# **SPECTRA<sup>®</sup>**

**HIGH PERFORMANCE FIBERS  
FOR REINFORCED COMPOSITES**

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for its series of ultra high strength fibers

*DePuy Mitek, Inc. v. Arthrex, Inc.  
C.A. No. 04-12457 PBS  
DMI003379*

# SPECTRA® EXTENDED CHAIN POLYETHYLENE FIBERS

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## 1. HISTORY

Extended Chain Polyethylene (ECPE) fibers are the most recent entrants in the high performance fibers field. SPECTRA® ECPE, the first commercially available ECPE fiber, was introduced in February 1985. They are the first in a family of extended chain polymers manufactured by Allied-Signal Corporation.

SPECTRA® ECPE fibers are, pound for pound, the highest modulus and strongest fibers ever made. This is a noteworthy achievement on two counts. First, because industry had relegated it to the status of a general purpose commodity polymer, polyethylene was not considered as a specialized high performance product. Second, the discovery was not made in a large industrial polymer laboratory, but from fundamental work by researchers in several leading universities. Although the work was supported by industry, the immediate outcome was not foreseen as a commercial entity. It is, however, an example of industry recognizing the value of revolutionary findings and exploiting the promise of technology. The result was the transformation of a commodity type polyethylene (PE) plastic into a high performance fiber.

Today, ECPE fibers are being utilized as a reinforcement in areas that, five years ago, were not accessible to any organic fiber. Applications such as ballistic armor, impact shields, and radar domes are being developed to take advantage of the unique properties of ECPE.

## 2. CHEMISTRY

SPECTRA® fibers are made from ultra-high molecular weight polyethylene (UHMPE). In contrast to aramids, PE is a flexible molecule which normally crystallizes by folding back on itself. As a consequence, PE fibers made by conventional technology do not possess outstanding physical properties. ECPE fibers, on the other hand, are manufactured by a process where most of the molecules are fully extended and oriented in the fiber direction, resulting in a dramatic increase in physical properties. A simplistic view of the structure on a molecular scale could be described as a bundle of rods, with occasional entangled points that tie the structure together. Conventional PE, on the other hand, contains a number of chain folds of short length which do not make a contribution to strength.

The key structural parameters that distinguish ECPE fibers from conventional melt spun materials are further illustrated in Figure 1. The molecular weight of UHMPE is generally 1 to 5 million, whereas conventional PE fibers are typically 50,000 to several hundred thousand. SPECTRA® fibers also exhibit a very high degree of crystalline orientation (95-99%), and crystalline content (60-85%).

## 3. MANUFACTURING

Two general routes can be used to achieve high-modulus PE fibers. The first is by extrusion, such as melt extrusion or by solid-state extrusion, utilizing lower molecular weight PE polymer and specialized drawing techniques. These processes lead to a fiber with high modulus, but relatively low strength and high creep. The second route involves solution spinning, where very high molecular weight PE can be utilized. With this process modification, a fiber with both high modulus and high strength is produced.

The solution spinning process for a generalized extended chain fiber begins with a polymer of approximately 1-5 million molecular weight, which is dissolved in a suitable solvent. The solution serves to disentangle the polymer chains—a key step in achieving an extended chain polymer structure. The solution is fairly dilute but viscous enough to be spun using conventional melt spinning equipment. The cooling of the extrudate leads to the formation of a fiber which can be continuously dried to remove solvent or later extracted by an appropriate solvent. The fibers are generally post drawn prior to final packaging.

Unlike most high performance processes, the solution spinning process is unusually flexible, providing an almost infinite number of process and product variations. Fiber strengths from 375 KSI to 560 KSI and tensile moduli of 15 MSI to 30 MSI have been achieved on a research scale by various companies worldwide. As the solution spinning process is modified, a higher tenacity (stronger) and more thermally stable yarn is produced. Circumstantial evidence (such as increased density, heat of fusion and x-ray orientation pattern) suggests that the increased strength and stability are caused by higher degrees of molecular orientation.

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## 4. APPLICATIONS

### 4.1 Fiber Properties

The comparative strengths of ECPE fibers versus other high performance fibers are summarized in Table 1. SPECTRA® 900, produced by Allied-Signal, will be used to illustrate the general properties of ECPE. SPECTRA® 1000 fibers are more stabilized, and exhibit a higher strength and modulus. In engineering terms, the tensile properties of ECPE are similar to many high performance fibers. However, because of the low density of PE (approximately 2/3 that of high modulus aramid and half that of high modulus carbon fiber), SPECTRA® fibers have extraordinarily high specific strengths and specific moduli. Pound for pound, the strength of SPECTRA® fiber is at least 35% greater than high modulus aramid or S-Glass, and about twice that of conventional high modulus carbon fiber. When comparing high performance fibers, it is often informative to employ a graphical illustration of Table 1. A two-dimensional plot of specific strength versus specific modulus for currently available fibers is given in Figure 2, again emphasizing the superior properties of SPECTRA®.

Polyethylene is also known as a system where traditional binders and wetting agents have proven to be ineffective in improving adhesion levels. ECPE fibers have shown that this characteristic is actually advantageous in specific areas. For instance, ballistic performance is inversely related to the degree of adhesion between the fiber and the resin matrix. For applications which need higher levels of adhesion and wetout, extensive research has been performed on SPECTRA® fibers. It has been found that by submitting the fiber to specific surface treatments, such as corona discharge or plasma treatments, the adhesion of the fiber to various resins is dramatically increased (see Table 2).

The main application areas being explored and commercialized today for SPECTRA® fibers are divided into two main thrusts: traditional fiber applications such as sailcloth, marine ropes, cables, sewing thread, nettings, and protective clothing; and high tech composite applications, such as ballistics, impact shields, medical implants, radomes, pressure vessels, boat hulls, sports equipment, and concrete reinforcement.

### 4.2 Sailcloth

World class competition of high performance sail boats (such as the Americas Cup) has become more competitive, forcing the sail industry to experiment with new materials. A winning sailcloth must possess high strength, high modulus, light weight and minimal distortion during the sailing season. Of the fiber physical properties, none are more critical than low creep and resistance to sea water and cleaning agents. Because of its superior strength-to-weight ratio and low creep response, SPECTRA® 1000 fibers are ideally suited for high performance yachting sails. Further, PE fibers are resistant to sea water and to typical cleaning solutions used in the boating industry, such as clorox (see Figure 3).

The creep behavior of SPECTRA® extended-chain fibers under typical laboratory test loadings of 3-4 gram/denier is illustrated in Figure 4. These creep levels are substantially below those encountered with conventional PE or the specialized high modulus fibers from melt spinning. At this loading, which includes the initial elastic loading component, the creep level of SPECTRA® 1000 is comparable to that of a high modulus aramid. The elastic load component is included in these results on a practical basis since it is an integral part of the sail cloth design.

### 4.3 Marine Ropes

High strength, light weight, low moisture absorption and excellent abrasion resistance all make ECPE a natural candidate for marine rope. Three parameters of SPECTRA® 900 rope (diameter, weight per length, and strength) are illustrated in Table 3. Since aramid fibers are the accepted standard in the high performance rope industry, aramids will be used here to provide a yardstick by which the ECPE fibers can be measured. SPECTRA® 900 braid is 12% smaller, 10% stronger and 52% lighter than the aramid product.

The important considerations in marine rope applications are load, cycling and abrasion resistance. The response of a SPECTRA® 900 rope to load cycling was measured by testing on a sheave device. The rope was repeatedly loaded to 4000 lb until it broke. In this type of test, a 12 strand ECPE braid withstood approximately eight times the number of cycles that led to failure in the control 12 strand aramid braid (Table 4). Abrasion resistance was measured by cycling the rope over an oscillating bar. In this test, 0.5 inch diameter ECPE braided rope withstood eight times the abuse of a similar aramid rope (Table 4).

### 4.4 Cut Resistant Gloves And Protective Clothing

The specially toughened and dimensionally stabilized SPECTRA® 1000 yarn has made a revolutionary new line of cut-resistant products. This technology offers a previously unattainable level of protection from cut and abrasion without sacrificing comfort and launderability. Spectra® fibers are being used in the form of cut resistant gloves, arm guards and chaps. Specific industries involved include: meat packing, commercial fishing, poultry processing, sheet metal work, glass cutting, and power tool use. The inert chemical nature combines with cut protection for non-permeable over-gloves in surgical, dental, laboratory testing, and police emergency response applications.

### 4.5 Ballistic Protection

ECPE's high strength and modulus and low specific gravity offer higher ballistic protection at a lower areal density than is possible with currently used materials. It can be used in flexible and rigid armor.

Flexible armor is manufactured by joining multiple layers of fabric into the desired shape. The style of the fabric and number of layers will determine the

ballistic resistance that the armor will provide. Typical V50 ballistic limits of plain weave SPECTRA® fabrics of different denier yarns are plotted as functions of areal density in Figure 5. Applications include protective vests for military personnel and civilian security forces as well as ballistic blankets. These blankets can be applied to ceramic and metallic armor as a front spall shield and as a rear spall suppressor. They can also be used to fabricate ballistic protective shelters.

Traditional rigid armor can also be made by utilizing woven ECPE fiber in either thermoset or thermoplastic matrices. These rigid systems exhibit high ballistic protection due to the fiber strength and modulus in combination with its low specific gravity; that is, maximum ballistic protection is achieved with minimum weight. This increased protection is illustrated in Figure 6, which compares V50 values for SPECTRA® fiber and aramid composites against a 22 caliber fragment simulator.

The ECPE fiber ballistic systems can be contoured or formed into armored plates, helicopter seats, Army or police helmets, and many other product forms. It is important for these systems to maintain their ballistic protection under a wide range of environmental conditions. For example, Figure 7 illustrates the superior performance of SPECTRA® fiber armor, even at temperatures as high as 225°F. This performance, along with the low moisture absorption, chemical inertness, and low weight characteristics make ECPE fibers a natural in the ballistic area.

## 4.6 Composites

ECPE fibers are recent entrants into the high performance composite industry. Their high strength and high modulus were the main attributes which attracted the composite industry, leading to the investigation of potential applications.

SPECTRA® fibers have been used with a wide variety of resin systems, including: epoxies, polyesters, vinylesters, silicones, urethanes and polyethylene. The choice of resin is most often dictated by the end use application and requirements. Epoxy and IPN resins provide the highest mechanical properties currently reported; epoxies being used most often by the composites industry, and IPNs gaining importance in RIM/RTM processes. Vinyl ester and urethanes, on the other hand, offer the greatest impact and ballistic properties at the expense of mechanical strength. Polyester is intermediate to the two groups, and is most often used in the radome industry for its electrical properties. ECPE fibers can be processed essentially the same as aramid, graphite, and glass. Hand layup, matched mold, pressure, and vacuum molding of fabric prepregs are most often used; however, filament winding and pultrusion are also common with continuous filament.

SPECTRA® fibers can be found in various forms; roving, fabric, continuous mat, and even chopped fiber. Composite applications where high strength (i.e. tensile, flexural, or short beam shear) are needed require special fiber treatments to enhance the fiber

to matrix adhesion. Allied-Signal, Inc. has developed proprietary treatments for their SPECTRA® fibers to increase the adhesion level and composite properties.

### 4.6.1 Composite Applications

SPECTRA® fiber reinforced materials are being developed and used widely in ballistics, radar protective domes, aerospace, sport equipment, and industrial applications. Some of these areas utilize the fiber in hybrid form, i.e. in combination with S-2 Glass, Graphite, Aramid, and/or Quartz.

Ballistics are so far the dominant market segment. Components include helmets, helicopter seats, automotive and aircraft armor, bullet proof radomes, and other industrial structures.

Radar protective domes (radomes) is another market utilizing ECPE fibers. Because of the excellent electrical properties of polyethylene, SPECTRA® composite systems act as a shield that is virtually transparent to microwave signals, even in high frequency regions. Hybridization with quartz or glass fiber are also attractive from the structural, cost, and performance point of view.

The major sport equipment applications to date have been canoes, kayaks, snow and water skis. Numerous other sport applications are under development, including: bicycles, golf clubs, ski poles, and tennis rackets. Further growth is expected in formula race car bodies.

The industrial market is taking advantage of SPECTRA® fibers in areas where increased strength, impact resistance, non-catastrophic failure, lightweight, or corrosion resistance are required. The corrosion resistance has led the composite industry to investigate applications where parts are exposed to a wide variety of chemical elements. Until now, standard high performance fibers could not function under such adverse conditions.

## 5. PROPERTIES OF COMPOSITES

The various fiber characteristics discussed so far can be translated into several unique composite properties. The following discussion will be organized into the following categories:

1. Ballistic
2. Impact
3. Electrical
4. Structural

### 5.1 Ballistic Performance

The ballistic performance of SPECTRA® fabrics has been presented as a function of areal density and fiber denier in the ballistic protection section. The excellent protection of SPECTRA® fabrics can be translated into hard armor composites. For example, ballistic protection against .22, .30, and .50 caliber threats is summarized in Figure 8. Looking back to Figure 6, one can see the advantage of SPECTRA® composites over similar composites reinforced with aramid fibers for fragmentation protection.

Handgun projectiles present a different type of threat, and again, SPECTRA® composites face up to the challenge with reduced weight and increased protection over aramid composites. The resistance to handgun ammunition of SPECTRA® and aramid composites are compared in Table 5. In every case, the SPECTRA® composites demonstrate lower areal density and/or increased protection.

## 5.2 Impact Resistance

Energy dissipation is one of the most outstanding features of ECPE. For instance, a comparison of fabric composites of SPECTRA®, Glass, Kevlar and Graphite under impact conditions is presented in Table 6. The SPECTRA® composite panels had significantly better impact properties, and were not "through penetrated" as the other panels were. Another unique behavior of SPECTRA® composites under impact loading is highlighted by repetitive impact studies. Figure 9 presents repetitive impact data for a similar SPECTRA® composite panel. Toughness gradually increases after each successive impact, working to extend the actual part life.

Drop weight instrumented impact tests were also performed on honeycomb sandwich composites. Again, the peak forces resisted by the SPECTRA® plates were consistently higher than similar aramid plates (Table 7). The peak impact force, total impact energy, and energy absorbed to peak force increase with the increase in face sheet thickness, from 1 to 3 plies. Resistance to hailstorm erosion is a practical example of the advantages that can be gained from the tremendous impact resistance offered by SPECTRA® honeycomb sandwich composites. A comparison with other reinforcements in a simulated hailstorm test is shown in Figure 10.

With the new surface treatments developed to enhance the fiber-resin interface adhesion, direct effects on the impact performance can be seen in Table 6. It should be noted that although the impact properties have decreased, the impact resistance of treated SPECTRA® composites is still five times that of glass or aramid, with a significant increase in physical properties.

## 5.3 Electrical Properties

Radar protective covers (radomes) are gaining an increasingly important role in today's radar systems. The most important attribute for a radome to possess is to be as close to "invisible" or "transparent" to the signal as possible. Because of the low dielectric constant and loss tangent of polyethylene, (see Table 8) SPECTRA® fiber composite systems can fulfill this requirement better than any other high performance fiber. The SPECTRA® composite low dielectric constant (2.3-2.5) has been shown to hold in the high frequency ranges, even up to the millimetric band. The superior electrical properties of ECPE fibers can be utilized in single fiber systems, or can be used to improve the properties of glass radomes via hybridization. A dielectric constant of 2.9 has been obtained with a SPECTRA®/Glass (25/75) hybrid system.

The advantages of low dielectric and low loss UHSPE fibers in radar systems can be demonstrated by observing the effect of the radome on the transmission ratio. The transmitted signal of a typical SPECTRA® radome matrix is compared with a glass radome at various ratios of wall thickness to wavelength in Figure 11. The SPECTRA® radome causes much less distortion of the signal. This advantage is even more pronounced in Type A honeycomb sandwich panels (Figure 12). By causing less signal reflection and absorbance, SPECTRA® fiber composite systems are uniquely suited to radome applications.

Other possible electrical applications for ECPE fibers and their reinforced composites are electrical shelters, x-ray tables, optical cables, and other structures where high strength non-conductive characteristics are needed.

## 5.4 Structural Properties

Static test results for SPECTRA® 900 and SPECTRA® 1000 unidirectional composites are summarized in Table 9. All test samples were cut from unidirectional prepregs of corona treated ECPE fiber with Shell Epon 825 epoxy resin and Mellamine 5260 cycloaliphatic diamine curing agent. The strength and modulus of SPECTRA® 1000 are higher than the SPECTRA® 900 composites, due to the improved strength of the SPECTRA® 1000 fiber. Further improvements in composite properties can be achieved by applying the plasma surface treatment to the fibers. This treatment increases the interfacial bonding, which translates into even higher composite structural properties, as described previously in Table 2.

The continuing research in improving the ECPE fiber-matrix compatibility along with hybridization with other high performance fibers open a wide new area in composite properties. These developments are currently being explored by scientists at Allied-Signal.

Figure 1. Fiber Morphology.

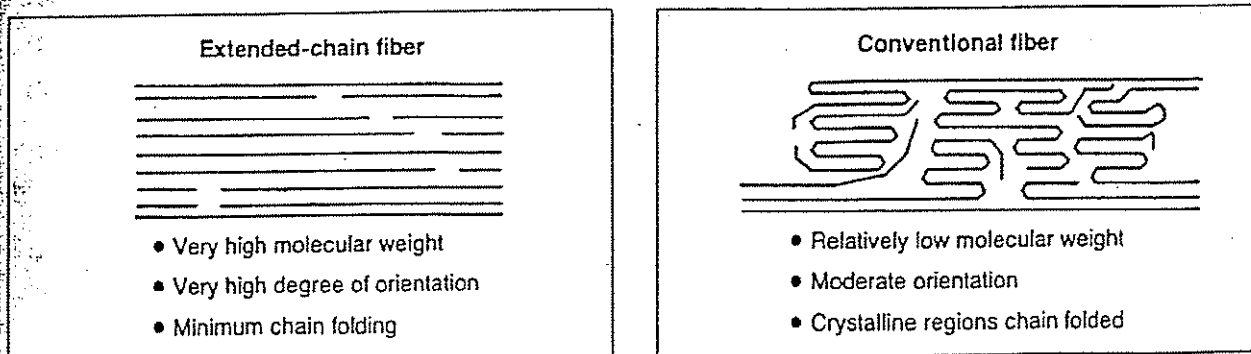
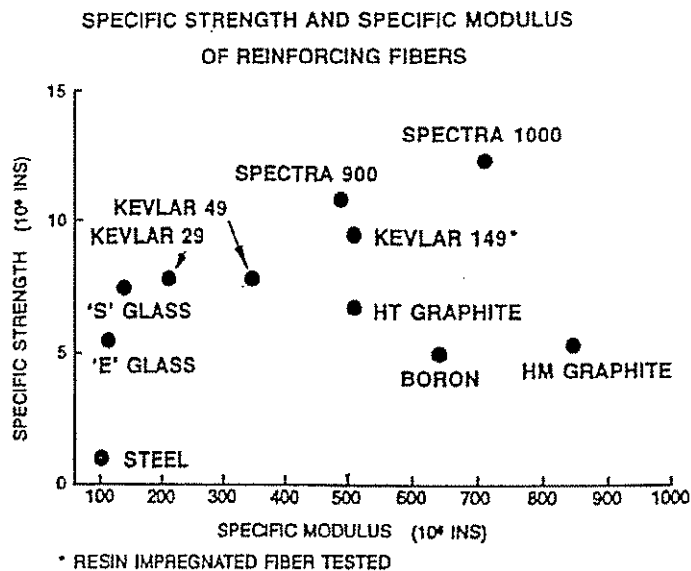


TABLE 1  
HIGH PERFORMANCE FIBER PROPERTIES

Property	UHSPE SPECTRA 1000	ARAMID HM	ARAMID UHM*	S-Glass	Graphite HM
Density	0.97	1.44	1.47	2.49	1.86
Elongation, %	2.7	2.5	1.5	5.4	0.6
Tensile Strength, 10 <sup>3</sup> psi	435	400	500	665	375
Specific Strength, 10 <sup>6</sup> in	12.4	7.8	9.5	7.4	5.4
Tensile Modulus, 10 <sup>6</sup> psi	25	19	25	13	57
Specific Modulus, 10 <sup>6</sup> in	714	365	480	140	850

\* Kevlar 149—Epoxy Impregnated Strand

Figure 2. Comparative tensile properties of various reinforcing fibers.



**TABLE 2**  
**UHSPE FIBER ADHESION IMPROVEMENTS**

Fiber: SPECTRA® 900

Resin: Epoxy

Fiber Loading: 60%

Date	Treatment	Unidirectional			Fabric (Style 903)		
		SBS (KSI)	Flex Str (KSI)	Flex Mod (MSI)	SBS (KSI)	Flex Str (KSI)	Flex Mod (MSI)
10/85*	TN <sup>1</sup>	1.16	21.2	1.2	0.87	5.7	0.44
10/86	CT <sup>2</sup>	2.61	27.6	2.6	1.4	10.3	1.0
10/87	TP <sup>3</sup>	4.50	33.9	4.5	2.2	21.0	2.9

\* Market Introduction

<sup>1</sup> No Treatment

<sup>2</sup> Corona Treatment

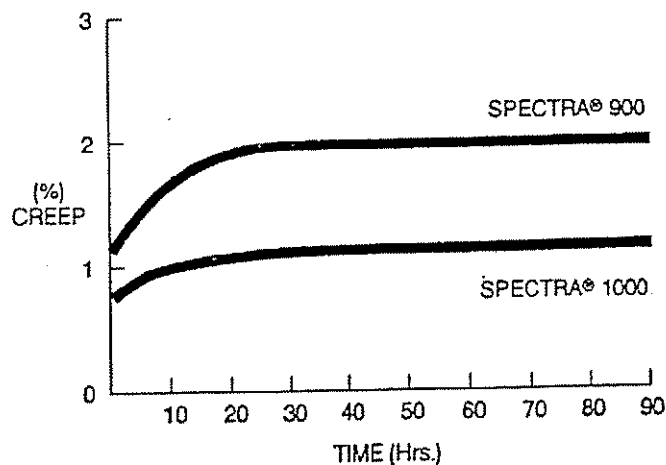
<sup>3</sup> Plasma Treatment

Figure 3. Chemical resistance.

Agent	% Strength Retention After 6 Months Immersion	
	SPECTRA 900	Aramid
Sea Water	100	100
10% Detergent solution	100	100
Hydraulic fluid	100	100
Kerosene	100	100
Gasoline	100	93
Toluene	100	72
Perchlorethylene	100	75
Glacial acetic acid	100	82
1M Hydrochloric acid	100	40
5M Sodium hydroxide	100	42
Ammonium hydroxide (29%)	100	70
Hypophosphite solution (10%)	100	79
Clorox®	91	0

Immersed in various chemical substances for a period of 6 months, SPECTRA fibers retained their original strength.

Figure 4. Creep at 10% load (room temperature).



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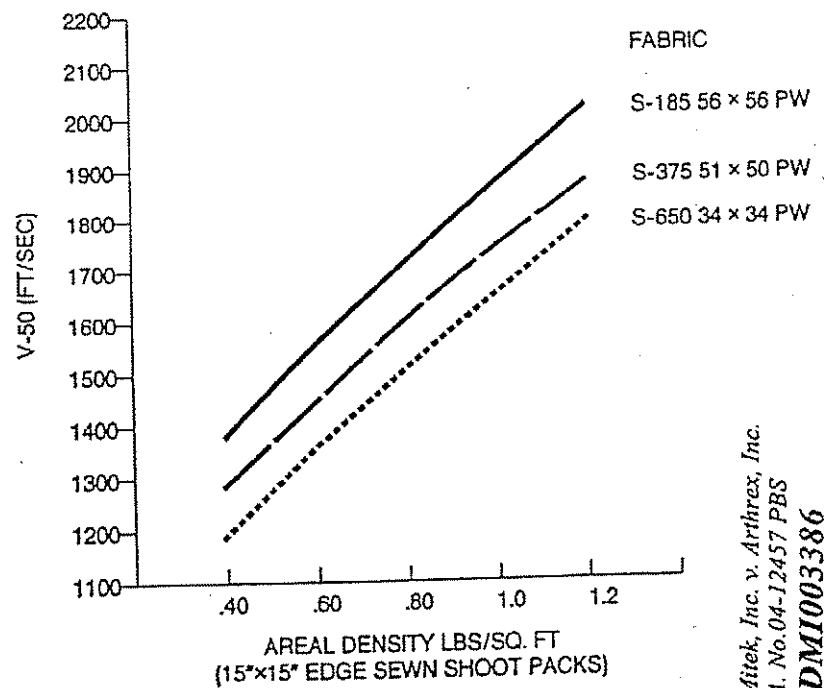
TABLE 3  
COMPARATIVE PROPERTIES OF 16-STRAND ROPE

Property	SPECTRA® 900	Aramid
Diameter (In)	0.088	0.10
Wt/100 Ft (Lb)	0.153	0.32
Tensile Strength (Lb)	1465	1334

TABLE 4  
CYCLE LOADING AND WEAR TESTS

	SPECTRA® 900	Aramid
Cyclic Sheave - 12 Strand Braid (10 Cycles/Min, 4000 Lb Tensile Load) Cycles to Break	10,231	1212
Oscillating Bar - 0.5 In. Rope (1.5 Cycles/Min, 1700 Lb Tensile Load) Cycles to Break	883	111

Figure 5. Ballistic performance of SPECTRA® fabrics.



.22 CAL 17 GR FSP

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Figure 6. Ballistic performance of Spectra® and Aramid composites.

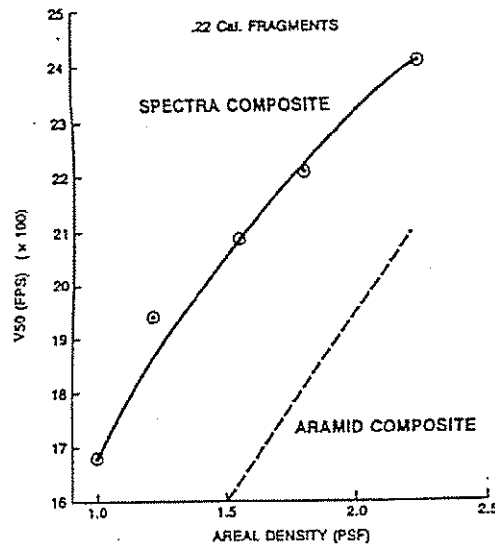


Figure 7. Spectra® fabric ballistic performance at elevated temperatures.

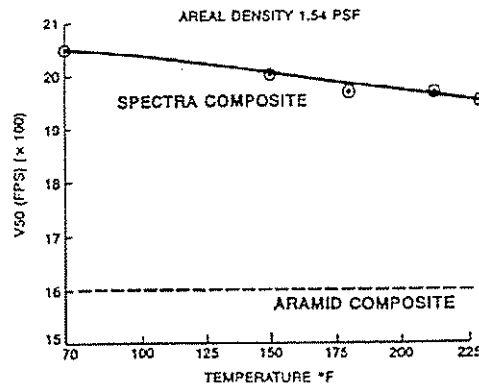
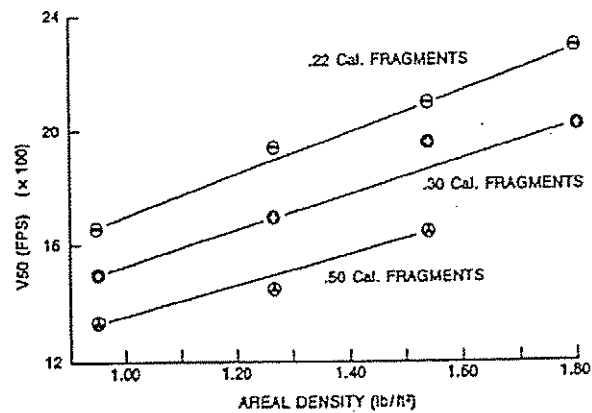


Figure 8. Spectra® composite ballistic protection versus .22, .30 & .50 caliber fragments.



**TABLE 5**  
**RESISTANCE TO HANDGUN AMMUNITION OF**  
**SPECTRA® AND ARAMID COMPOSITES**

Ammunition	No.	Armor System	AD (PSF)	V50 (FPS)
.357 Cal. 158 grain JSP	1	Spectra/Vinylester 411-45	0.62	1220
	2	Spectra/Vinylester 411-45	1.12	1443
	3	Kevlar/Polyester	1.15	1281
	4	Spectra/Vinylester 411-45	1.36	1481
	5	Kevlar/Polyester	1.49	1311
9mm 124 grain FMJ	6	Spectra/Vinylester 411-45	0.62	1082
	7	Spectra/Latex	0.70	1200
	8	Spectra/Vinylester 411-45	0.83	1173
	9	Spectra/Latex	1.01	1454
	10	Spectra/Latex	1.23	1594
	11	Kevlar/Polyester	1.28	1241
	12	Kevlar/Polyester	1.46	1372
	13	Spectra/Latex	1.53	1624

Products: Spectra 1000 and Kevlar 29

**TABLE 6**  
**INSTRUMENTED IMPACT OF FABRIC COMPOSITES**

Resin: Epoxy Resin

Fiber Vol. Loading: 60%

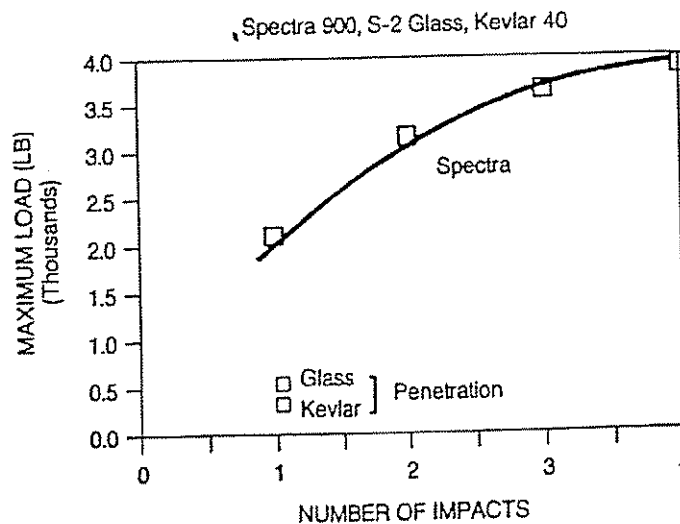
Fiber	Treatment	Max Load (Lb)	Energy At Max Load (Ft-Lb)	Total Energy (Ft-Lb)	Observation
SPECTRA 900	TN <sup>1</sup>	1660	47.4	54.5	No Penetration
SPECTRA 900	TP <sup>2</sup>	1030	12.0	28.0	Penetration
Kevlar 49	EC <sup>3</sup>	254	1.3	6.7	Penetration
S-2 Glass	EC	370	1.8	4.4	Penetration
HM Graphite	EC	133	1.2	2.5	Penetration

<sup>1</sup> No Treatment

<sup>2</sup> Plasma Treatment

<sup>3</sup> Epoxy Compatible

**Figure 9.** Repetitive impact of Spectra® composites.



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 DMI003388

**TABLE 7**  
**IMPACT ABSORPTION OF SANDWICH COMPOSITES**

Core: ½ in. honeycomb (3 lb./cu. ft.)  
Resin: Epoxy (Epon 826)

Skin	No. of Layers	Energy to Peak Force (ft. lb.)	Total Energy Absorbed (ft. lb.)
SPECTRA 900	1	22.4	61.5
Aramid	1	0.7	23
SPECTRA 900	3	33.5	59.8
Aramid	3	1.5	10.5

Figure 10. Hailstorm test on Type A composite sandwich panels courtesy of Norton Company, Ravenna, OH.



**TABLE 8**  
**FIBER ELECTRICAL PROPERTIES**

Material	Dielectric Constant	Loss Tangent
SPECTRA	2.0-2.3	0.0002-0.0004
E-Glass	4.5-6.0	0.0060
Aramid	3.85	0.0100
Quartz	3.78	0.0001-0.0002

Figure 11. Transmission versus relative thickness for flat panels at 8.5 GHz.

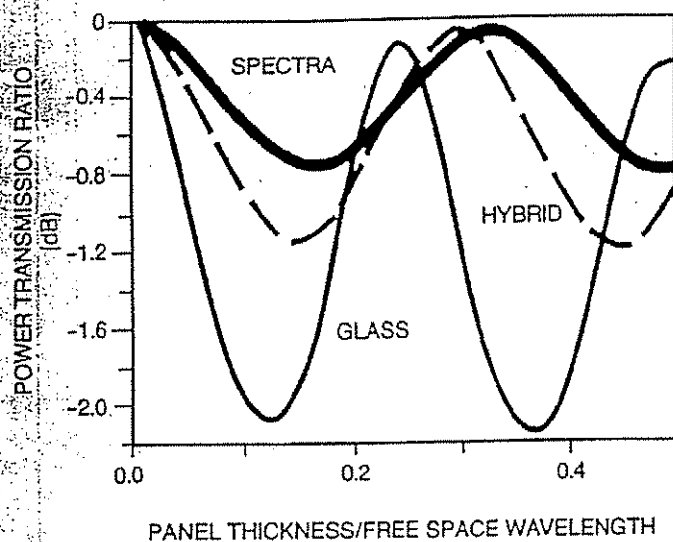


Figure 12. Transmission versus relative thickness Type A, sandwich radome test panel at 8.5 GHz.

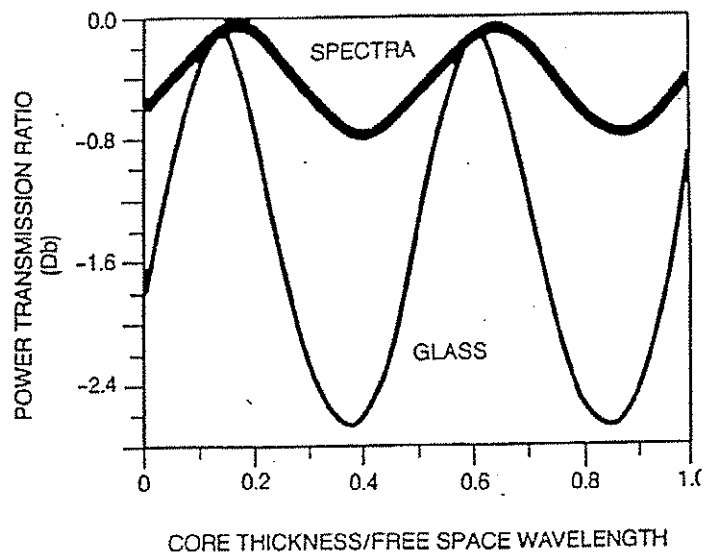


TABLE 9  
PROPERTIES OF UNIDIRECTIONAL COMPOSITES  
(NON TREATED FIBER)

	Spectra® 900	Spectra® 1000
Axial tensile strength (10 <sup>3</sup> psi)	174	217
Axial tensile modulus (10 <sup>6</sup> psi)	5.8	9.1
Axial strain to failure (%)	3.8	2.6
Major Poisson's Ratio	0.32	0.28
Transverse tensile strength (10 <sup>3</sup> psi)	1.4	1.5
Transverse tensile modulus (10 <sup>6</sup> psi)	0.6	0.2
Axial compressive strength (10 <sup>3</sup> psi)	15.8	16.0
Axial compressive modulus (10 <sup>6</sup> psi)	—	3.6
Short beam shear strength (10 <sup>3</sup> psi)	4.0	2.5

# EXHIBIT C

①

# Engineers' Guide to Composite Materials

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5-26

Property Data: Reinforcements | Fiber and Whisker Reinforcements

## Mechanical Properties of Aramid, Polyamide, Polyester, and Nylon Fibers

Fiber	Density		Tensile strength		Tensile modulus		Ultimate elongation, %
	Mg/m <sup>3</sup>	lb/in. <sup>3</sup>	MPa	ksi	GPa	10 <sup>4</sup> psi	
Aramid-Kevlar 29 .....	1.44	0.052	3620	525	83	12	4.4
Aramid-Kevlar 49 .....	1.44	0.052	3620	525	124	18	2.9
Polyamide .....	1.13	0.041	830	120	2.8	0.4	...
Polyester-Dacron Type 68 .....	1.38	0.050	1120	162	4.1	0.6	14.5
Nylon-Du Pont 728* .....	1.13	0.041	990	143	5.5	0.8	18.3
Spectra-900 .....	0.97	0.035	2590	375	117	17	...

\*Unimpregnated twisted yarn test—ASTM D2256.

## Effect of Tension-Tension Fatigue on Aramid (Kevlar 29) Fibers (Du Pont Co.)

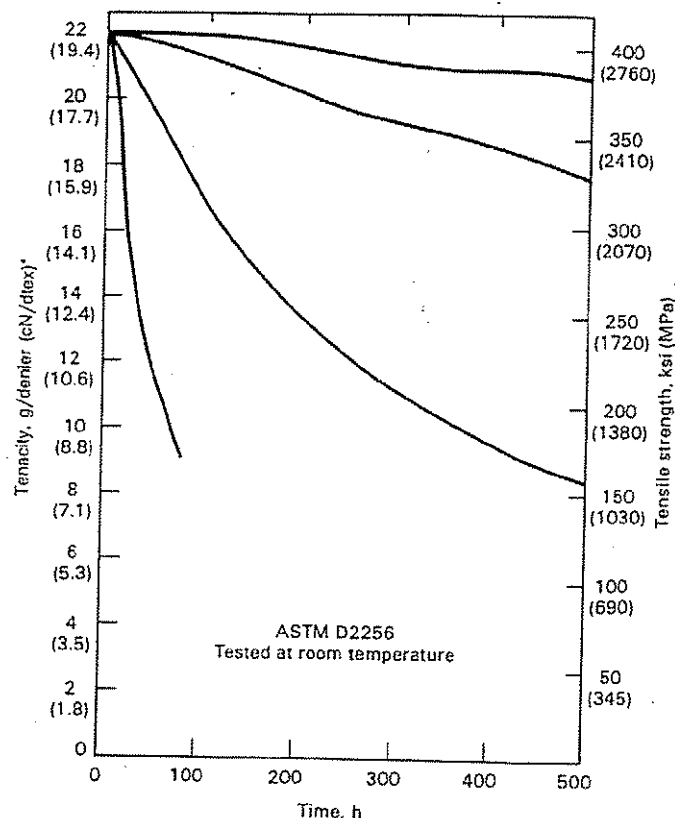
Cycled between (% of ultimate tensile strength)		No. of cycles	Break load after cycling		Decrease in tensile strength due to fatigue
High	Low		N	lb	
Control	...	...	552	124	...
74	45	1000	578	130	None
52	29	1000	610	137	None
31	8	1000	587	132	None
10	0	13 × 10 <sup>6</sup>	525	118	5%

1500 denier (1670 dtex) 2-ply yarn of Kevlar 29 was tested using air-actuated 4-D cord clamps on an Instron test machine, at 254 mm (10 in.) original gage length, 10% per minute elongation, 55% R.H., and 22 °C (72 °F).

## Coating Materials Used Successfully With Kevlar 29 Aramid Fiber (Du Pont)

Coating	Typical end uses
Neoprene synthetic rubber .....	Inflatable boats
Hypalon synthetic rubber .....	Pond liners, tarpaulins
Nitrile rubber .....	Pressure diaphragms
Nordel	
hydrocarbon rubber .....	Heat-resistant conveyor belts
Buna-N .....	Hoses
Urethane polymers .....	Inflatable structures
Silicon and fluorosilicon .....	Belting
Polyvinyl chloride .....	Air-supported structures
Teflon (TFE, FEP)	
fluorocarbon resin .....	Nonstick belts
Polyvinyl alcohol .....	Specialty uses
Laminations:	
Tedlar polyvinyl fluoride .....	Lighter-than-air craft
Mylar polyester	

## Effect of Temperature on Tensile Strength of Aramid (Kevlar 29) Fiber (Du Pont Co.)



\*Conversion factor:  $\frac{\text{lb}}{\text{in.}^2} = \left( \frac{\text{g}}{\text{denier}} \right) \times \text{density} \left( \frac{\text{g}}{\text{cm}^3} \right) \times 12\,800$

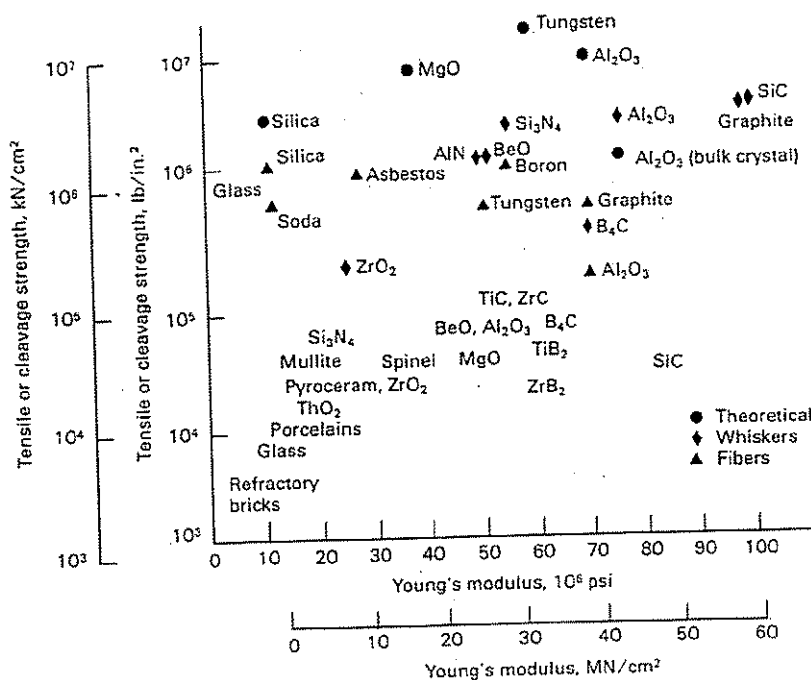
## Chemical Resistance of Kevlar (Ref 34)

Chemical	Concentration, %	Temperature		Time, h	Strength loss, %	
		°C	°F		Kevlar 29	Kevlar 49
Hydrochloric acid .....	37	21	70	100	72	63
Hydrochloric acid .....	37	21	70	1000	88	81
Hydrofluoric acid .....	10	21	70	100	10	6
Nitric acid .....	1	21	70	100	16	5
Nitric acid .....	10	21	70	100	79	77
Sulfuric acid .....	10	21	70	100	9	12
Sulfuric acid .....	10	21	70	1000	59	31
Sodium hydroxide .....	10	21	70	1000	74	53
Ammonium hydroxide .....	28	21	70	1000	9	7
Acetone .....	100	21	70	1000	3	1

(continued)

## Fiber Property Data | Comparative Tables of Selected Fibers and Whiskers

## Strength Vs. Modulus for Tungsten and Various Ceramics in Bulk, Fiber, and Whisker Forms (Ref 8, p 359)

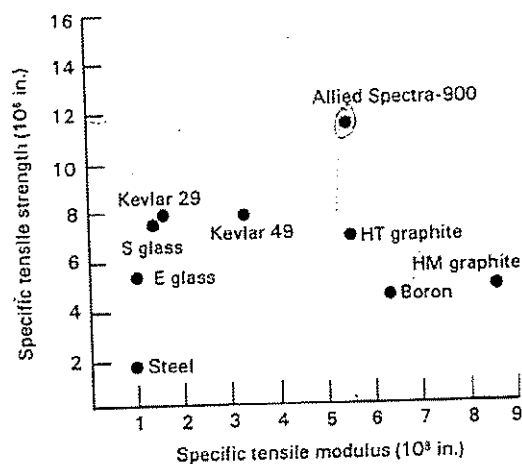


## Comparative Mechanical Properties of Kevlar, Glass, and Graphite Fibers (Du Pont Co.)

Property	Kevlar 29	E glass	Graphite
Tensile strength <sup>a</sup> :			
MPa	3620	2415	2760
ksi	525	350	400
Tensile modulus <sup>a</sup> :			
GPa	82.7	68.9	220
10 <sup>6</sup> psi	12	10	32
Density:			
g/cm <sup>3</sup>	1.44	2.52	1.74
lb/in. <sup>3</sup>	0.052	0.091	0.063
Brittleness	Tough	Brittle	Brittle
Abrasiveness	No	Yes	Yes

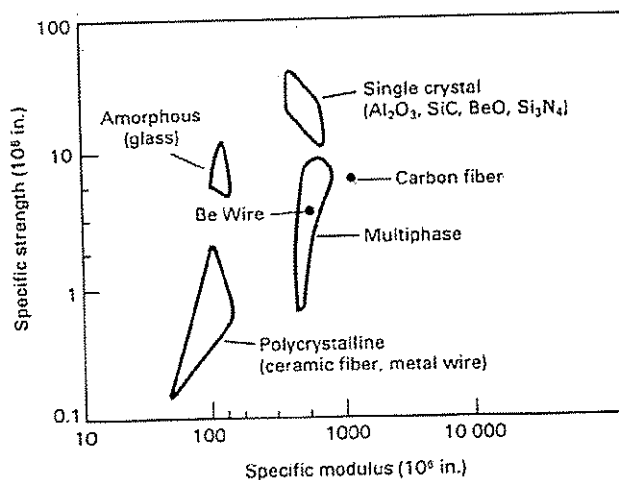
<sup>a</sup>Resin-impregnated strand test.

## Specific Strength Vs. Specific Modulus for Reinforcing Fibers (Allied Fibers)



## Room-Temperature Specific Strength and Specific Stiffness of Several Fibers (Ref 11, p 25)

Specific values in this figure were determined by dividing strength or modulus by density, expressed in lb/in.<sup>3</sup> or kg/M<sup>3</sup>.



## Characteristics of Carbon-Boron Alloy Fiber Groups (Ref 73)

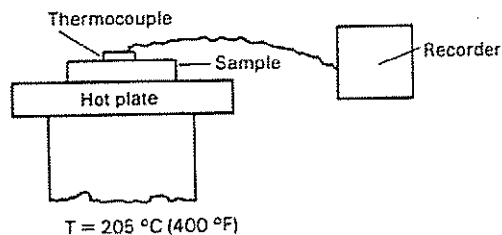
Characteristic	Group			
	A	B	C	D
Carbon interlayer	No	No	Yes	Yes
Number of CVD reaction chambers	4	3	3	3
Boron content <sup>a</sup> , wt %	43-46	35-39	46-48	48-51

<sup>a</sup>Unpublished research, D. L. McDaniel, NASA Lewis Research Center.

## Thermal Conductivity of Kevlar Felts and Fabrics Vs. Other Materials (Du Pont Co.)

Fabric	Weight g/m <sup>2</sup>	Weight oz/yd <sup>2</sup>	Thickness mm	Thickness mils	Lag time, s	Thermal conductivity, cal/cm <sup>2</sup> ·s·°C	Temperature rise in 25 s °C	Temperature rise in 25 s °F
Kevlar 29 (1 ply) .....	333	9.8	0.76	30	0	0.324	60	108
Kevlar 29 (3 ply) .....	998	29.4	2.16	85	3	0.162	30	54
Kevlar 29 (felt) .....	917	27.0	2.67	105	1.5	0.084	16	28
Fiberglass (1 ply) .....	285	8.4	0.30	12	0	0.600	111	200
Fiberglass (8 ply) .....	2282	67.2	2.16	85	5.1	0.105	19	35
Asbestos .....	1386	40.8	2.29	90	2.5	0.168	31	55

Schematic of Test Apparatus for Determining Lag Time



Lag time is time between placing sample in contact with hot plate and any perceptible recorder readout.

## Some Typical Fabric Dimensions (Hexcel-Trevarno)

Construction	Weave	Thickness, mils	Width, in.	Weight, oz/yd <sup>2</sup>
<b>Graphite</b>				
12.5 × 12.5	Plain	7.2	42	5.7
24.0 × 24.0	Satin	13.5	42	10.9
10.5 × 10.5	Plain	6.0	42	5.5
16.0 × 24.0	Plain	6.1	38	4.7
<b>Kevlar</b>				
34 × 34	Plain	4.5	38	1.8
50 × 50	Satin	11	38	5.0
22 × 22	Plain	4.5	38	2.2
17 × 17	Plain	10	38, 50	5.0
17 × 17	Crowfoot	10	38, 50	5.0
13 × 13	Plain	10	50	5.0
16 × 16	Satin	13	50	9.0
28 × 28	Basket	20	50	10.5
26 × 22	Basket	26	44, 50, 60	13.5
17 × 30	Plain	7	38	3.1
<b>S Glass</b>				
24 × 22	Plain	5.5	38	3.7
18 × 18	Plain	9	38	5.8
48 × 30	Crowfoot	9	38	8.8
57 × 30	Crowfoot	5.5	38	5.4
57 × 54	Satin	8.5	38	8.9
<b>Ceramic</b>				
48 × 47	Satin	9.0	38	7.5

## Comparative Textile Fiber Properties (Ref 90)

	Spectra		Aramid		Carbon	
	900	1000	LM	HM	HT	HM
Denier/Number of filaments	1200/118	650/120	1500/1000	1500/1000	1730/3000	1630/3000
Tenacity, g/d	30	35	22	22	20	14
Elongation, %	3.5	2.7	3.6	2.8	1.2	0.6
Tensile modulus, g/d	1400	2000	488	976	1500	2400
Shrinkage at boil, %	<1	<1				
Specific gravity	0.97	0.97	1.44	1.44	1.73	1.81
Melting point, °C	147	147				
Filament size, μm	38	27	12	12	7.0	6.5

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## EXHIBIT D

2

# **The UHMWPE Handbook**

## **Ultra-High Molecular Weight Polyethylene in Total Joint Replacement**

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the elemental building blocks are individual metal atoms (e.g., Co, Cr, Mo) or relatively small molecules (e.g., metal carbides or oxides). However, in a polymer, the molecular size can comprise more than a 100,000 monomer units, with molecular weights of up to millions of g/mol.

The molecular chain architecture of a polymer also imparts many unique attributes, including temperature dependence and rate dependence. Some of these unique properties are further illustrated in the specific case of UHMWPE in subsequent sections of this chapter. For further background on general polymer concepts, the reader is referred to textbooks by Rodriguez (1989) and Young (1983).

### What Is Polyethylene?

Polyethylene is a polymer formed from ethylene ( $C_2H_4$ ), which is a gas having a molecular weight of 28. The generic chemical formula for polyethylene is  $-(C_2H_4)_n-$ , where  $n$  is the degree of polymerization. A schematic of the chemical structures for ethylene and polyethylene is shown in Figure 1.4.

For UHMWPE, the molecular chain can consist of as many as 200,000 ethylene repeat units. Put another way, the molecular chain of UHMWPE contains up to 400,000 carbon atoms.

There are several kinds of polyethylene (LDPE, LLDPE, HDPE, UHMWPE), which are synthesized with different molecular weights and chain architectures. LDPE and LLDPE refer to low-density polyethylene and linear low-density polyethylene, respectively. These polyethylenes generally have branched and linear chain architectures, respectively, each with a molecular weight of typically less than 50,000 g/mol.

HDPE is a linear polymer with a molecular weight of up to 200,000 g/mol. UHMWPE, in comparison, has a viscosity average molecular weight of up to 6 million g/mol. In fact, the molecular weight is so ultra-high that it cannot be measured directly by conventional means and must instead be inferred by its intrinsic viscosity (IV).

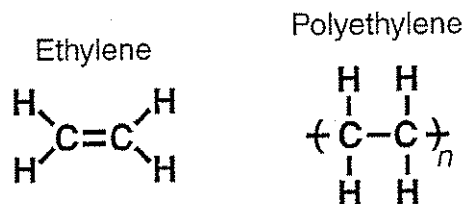
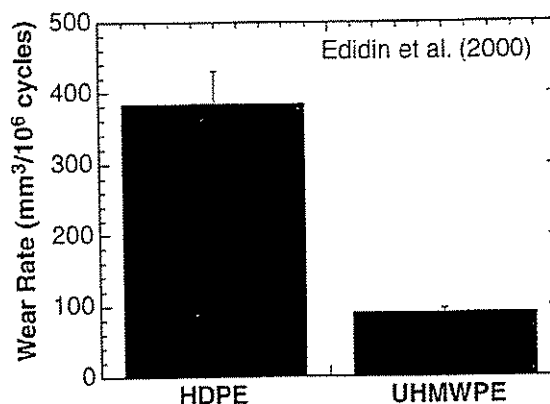


Figure 1.4

Schematic of the chemical structures of ethylene and polyethylene.



**Figure 1.5**

Comparison of wear rates of HDPE and UHMWPE in a multidirectional hip simulator. (From Edidin A.A., and S.M. Kurtz. 2000. The influence of mechanical behavior on the wear of four clinically relevant polymeric biomaterials in a hip simulator. *J Arthroplasty* 15:321–331.)

## Crystallinity

One can visualize the molecular chain of UHMWPE as a tangled string of spaghetti, more than a kilometer long. Because the chain is not static, but imbued with internal (thermal) energy, the molecular chain can become mobile at elevated temperatures. When cooled below the melt temperature, the molecular chain of polyethylene has the tendency to rotate about the C–C bonds and create chain folds. This chain folding, in turn, enables the molecule to form local ordered, sheetlike regions known as crystalline lamellae. These lamellae are embedded within amorphous (disordered) regions and may communicate with surrounding lamellae by tie molecules. All of these morphological features of UHMWPE are shown schematically in Figure 1.6.

The degree and orientation of crystalline regions within a polyethylene depends on a variety of factors, including its molecular weight, processing conditions, and environmental conditions (such as loading), and will be discussed in later chapters.

The crystalline lamellae are microscopic and invisible to the naked eye. The lamellae diffract visible light, giving UHMWPE a white, opaque appearance at room temperature. At temperatures above the melt temperature of the lamellae, approximately 137°C, UHMWPE becomes translucent. The lamellae are on the order of 10–50 nm in thickness and 10–50 µm in length (Kurtz et al. 1999). The average spacing between lamellae is on the order of 50 nm (Bellare, Schnablegger, and Cohen 1995).

The crystalline morphology of UHMWPE can be visualized using transmission electron microscopy (TEM), which can magnify the polymer by up to

summarizes the clinical performance of UHMWPE hip implants and discusses the patterns of wear and surface damage that occur during implantation. Chapter 6 describes alternatives to conventional UHMWPE in hip replacement. Chapters 7 and 8 relate to the development and clinical performance of UHMWPE in knee replacement. Chapter 9 is devoted to clinical applications of UHMWPE in the shoulder, and Chapter 10 covers the use of UHMWPE in the spine.

The topics outlined in this *Handbook* may be used as a resource in undergraduate, as well as graduate, courses in biomaterials and orthopedic biomechanics. Students in these disciplines can learn a great deal from exposure to the historical development of total joint replacements within the context of UHMWPE. The first two main sections of this book, which cover the fundamentals of UHMWPE and clinical applications in the spine and upper and lower extremities, are intended as a resource for undergraduate instruction.

The third section of this book, which covers more specialized topics related to UHMWPE, is intended for an audience of graduate students and orthopedic researchers. Chapter 11 covers the chemistry of UHMWPE following irradiation, which leads to oxidation and crosslinking of the material. Chapter 12 describes the characterization methods for UHMWPE in the context of regulatory submissions prior to clinical trials. In Chapter 13, we review the development of the small punch test, a miniature specimen mechanical testing technique that has recently been standardized. Chapter 14 describes the micromechanical modeling of conventional and highly crosslinked UHMWPE. The final chapter in this work, Chapter 15, is a compendium of the processing, packaging, and sterilization information for highly crosslinked and thermally treated UHMWPE materials that are currently used in hip and knee arthroplasty.

Understanding basic chemical structure and morphology is an important starting point for appreciating the unique and outstanding properties of UHMWPE. The chapters that follow and describe the processing, as well as the sterilization, of UHMWPE will continue to build on the conceptual foundation established in this introduction.

## References

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### Chapter I. Reading Comprehension Questions

- 1.1. Let A, B, and C be monomers. What is the molecular structure of a linear homopolymer?
  - a) -A-A-B-A-A-B-A-A-B-
  - b) -A-B-C-A-B-C-A-B-C-
  - c) -B-C-C-C-C-C-C-C-
  - d) -B-B-B-B-B-B-B-B-
  - e) -C-A-A-C-A-A-C-A-A-
- 1.2. Which of the following polymers is NOT synthesized from ethylene?
  - a) LLDPE
  - b) PTFE
  - c) UHMWPE
  - d) HDPE
  - e) LDPE
- 1.3. What is the major difference between HDPE from UHMWPE?
  - a) Molecular weight
  - b) Monomer
  - c) Chemical composition
  - d) Color
  - e) All of the above
- 1.4. What are the crystals in polyethylene made up of?
  - a) Folded molecular chains
  - b) Calcium stearate
  - c) Aluminum tetrachloride
  - d) Copolymer
  - e) Branched chain ends
- 1.5. UHMWPE exhibits which of the following transition temperatures?
  - a) Glass transition
  - b) Melting transition
  - c) Flow transition
  - d) Glass and melting transitions
  - e) Glass, melting, and flow transitions

## Exhibit 4

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1 UNITED STATES DISTRICT COURT  
2 DISTRICT OF MASSACHUSETTS  
3 C.A. NO. 04-12457 PBS

4 \_\_\_\_\_ x

5 DePUY-MITEK, INC.,  
6 A Massachusetts Corporation,  
7 Plaintiff,  
8 vs.

9 ARTHREX, INC.,  
10 A Delaware Corporation,  
11 Defendants.

12 \_\_\_\_\_ x

13 DAY 2 OF 2  
14 CONTINUED VIDEOTAPED DEPOSITION  
15 OF DR. MATTHEW HERMES  
16 Philadelphia, Pennsylvania  
17 July 25, 2006  
18  
19

20 Reported by:

21

22 PAMELA HARRISON, RMR, CRR, CSR

23

24

25

ORIGINAL

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		Page 314
1	little break.	12:24:33p
2	MR. BONELLA: Okay.	12:24:34p
3	THE VIDEOGRAPHER: Going off the	12:24:35p
4	record; the time on the video monitor is 12:23	12:24:36p
5	P.M.	12:24:40p
6	(A recess was had from 12:23	12:24:45p
7	P.M. to 12:36 P.M.; and then the proceedings	12:24:45p
8	continued as follows:)	12:24:45p
9	THE VIDEOGRAPHER: Going back on	12:36:53p
10	the record. The time on the video monitor is	12:36:55p
11	12:36 P.M.	12:36:58p
12	Please continue.	12:37:00p
13	BY MR. SABER:	12:37:03p
14	Q. Dr. Hermes, let me hand you what has	12:37:03p
15	been previously marked as Defendant's Exhibit-20.	12:37:06p
16	MR. BONELLA: Thank you.	12:37:13p
17	BY MR. SABER:	12:37:14p
18	Q. Have you ever seen this document	12:37:14p
19	before, sir?	12:37:21p
20	A. I don't believe so.	12:37:29p
21	Q. Are you familiar with the product	12:37:30p
22	Spectra?	12:37:35p
23	A. To some extent, Mr. Saber, yes.	12:37:42p
24	Q. Is it your understanding that Spectra	12:37:44p
25	is a fiber made of ultra high molecular weight	12:37:47p

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		Page 315
1	polyethylene?	12:37:52p
2	MR. BONELLA: Object to form.	12:37:53p
3	THE WITNESS: Yes, that is my	12:37:53p
4	understanding.	12:37:54p
5	BY MR. SABER:	12:37:55p
6	Q. Now, could you see in the -- why don't	12:37:55p
7	you -- well, never mind.	12:38:08p
8	Do you see there's a reference	12:38:11p
9	near the end of the second paragraph, on the	12:38:21p
10	first -- it's the third page of the exhibit, the	12:38:26p
11	first page of text, near the end of the second	12:38:29p
12	paragraph there is a reference to the term	12:38:35p
13	commodity-type polyethylene (PE)?	12:38:41p
14	A. I do see that, yes.	12:38:48p
15	Q. Do you have -- have you ever heard the	12:38:50p
16	term commodity-type polyethylene?	12:38:52p
17	A. Oh, I'm sure I have. I don't -- I	12:38:55p
18	can't recall in what context.	12:38:57p
19	Q. Do you have an understanding of what	12:39:05p
20	commodity-type polyethylene is?	12:39:07p
21	A. No, I don't. You know, this is a --	12:39:11p
22	this is an advertising brochure by Allied Fibers,	12:39:15p
23	Allied Signal, and I'm sure they have a meaning	12:39:20p
24	in their own mind and are trying to make a point,	12:39:22p
25	but I don't know what the point is, sir.	12:39:25p

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		Page 316
1	Q. Well, if you could read the first two	12:39:27p
2	parts here, the history and chemistry, I want to	12:39:30p
3	ask you a few questions about --	12:39:33p
4	A. Okay.	12:39:34p
5	Q. -- whether you agree or disagree with	12:39:34p
6	what's here.	12:39:37p
7	A. I notice that the title of this	12:39:38p
8	brochure is The Extended Chain of Polyethylene	12:39:40p
9	Fibers, so I assume we're talking about	12:39:42p
10	polyethylene.	12:39:46p
11	Q. Well, we're talking -- we'll be	12:39:46p
12	talking about this exhibit a little bit.	12:39:47p
13	A. Yeah, but we're -- it's an exhibit	12:39:48p
14	that's entitled polyethylene, so whatever we're	12:39:51p
15	talking about must be in the set of polyethylene.	12:39:52p
16	Q. If you could read the history and the	12:39:55p
17	chemistry, and I just want to ask you whether you	12:39:56p
18	agree or disagree with some of the things that	12:40:00p
19	are stated here.	12:40:03p
20	A. (Witness reviewing document.) Okay.	12:40:52p
21	Q. Do you see they use -- Allied Signal	12:40:53p
22	uses the term conventional polyethylene to	12:40:57p
23	compare it to the Spectra product?	12:41:00p
24	A. I see that they use that term, yes.	12:41:03p
25	Q. Do you have an understanding of what	12:41:05p

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		Page 317
1	they're talking about when they use the word	12:41:07p
2	conventional polyethylene?	12:41:09p
3	A. They appear to be taking polyethylene	12:41:13p
4	and breaking it up and making arbitrary	12:41:17p
5	distinctions on molecular weight. They talk of	12:41:21p
6	conventional polyethylene up to several hundred	12:41:25p
7	thousand molecular weight and select the	12:41:29p
8	continuum of 1 to 5 million for something they	12:41:32p
9	call the extended chain polyethylene.	12:41:37p
10	Q. Where it says molecular weight of	12:41:39p
11	ultra high molecular polyethylene?	12:41:43p
12	MR. BONELLA: What's the question?	12:41:45p
13	BY MR. SABER:	12:41:47p
14	Q. Do you see that, sir?	12:41:47p
15	A. I see that, yes.	12:41:48p
16	Q. Do you agree that -- with the	12:41:49p
17	molecular weight numbers reported for ultra high	12:41:54p
18	molecular weight polyethylene compared to	12:41:59p
19	conventional PE?	12:42:00p
20	A. Mr. Saber, I don't have any direct	12:42:03p
21	experience. I've seen the numbers 1 to 5 million	12:42:05p
22	used to characterize that form of polyethylene a	12:42:08p
23	number of times.	12:42:11p
24	Q. So you agree with the 1 to 5 million	12:42:13p
25	for ultra high molecular weight polyethylene?	12:42:15p

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		Page 318
1	A. I believe that's the range that gets	12:42:19p
2	quoted in a lot of -- in a lot of publications.	12:42:21p
3	Q. Do you agree with the 50,000 to	12:42:24p
4	several hundred thousand molecular weight for	12:42:28p
5	conventional polyethylene fibers?	12:42:31p
6	A. No, because I don't understand what	12:42:35p
7	conventional polyethylene means other than as	12:42:38p
8	outlined in this -- in this brochure.	12:42:42p
9	Q. Do you agree that the authors of this	12:42:48p
10	brochure are trying to tell someone of ordinary	12:42:52p
11	skill in the art that the molecular weight of --	12:42:57p
12	ultra high molecular weight of polyethylene is	12:43:04p
13	significantly different than the molecular weight	12:43:05p
14	of conventional polyethylene fibers?	12:43:10p
15	MR. BONELLA: Object to form.	12:43:14p
16	THE WITNESS: Mr. Saber, I don't	12:43:14p
17	know who they're speaking to in this document.	12:43:16p
18	I really don't know. It's not cited as a	12:43:18p
19	reference, so I can't answer that question as to	12:43:21p
20	who they're speaking to.	12:43:24p
21	BY MR. SABER:	12:43:26p
22	Q. Well, do you consider yourself a	12:43:26p
23	person of ordinary skill?	12:43:28p
24	A. I consider myself of ordinary skill in	12:43:30p
25	the suture art, yes --	12:43:33p

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		Page 319
1	Q. And --	12:43:35p
2	A. -- and in many others, but I don't	12:43:35p
3	know what you mean by what you said.	12:43:37p
4	Q. Right. Do you have an understanding	12:43:38p
5	that the authors are trying to say that the	12:43:41p
6	molecular weight of ultra high molecular weight	12:43:43p
7	PE is substantially higher than the molecular	12:43:48p
8	weight of conventional PE --	12:43:51p
9	MR. BONELLA: Object to form.	12:43:53p
10	BY MR. SABER:	12:43:54p
11	Q. -- that that's what they're trying to	12:43:54p
12	say?	12:43:55p
13	MR. BONELLA: Object to form.	12:43:56p
14	BY MR. SABER:	12:43:56p
15	Q. Do you have that understanding?	12:43:56p
16	MR. BONELLA: Object to form.	12:43:57p
17	Objection. Asked and answered.	12:44:00p
18	THE WITNESS: I understand	12:44:01p
19	that's the -- that's the content of the	12:44:02p
20	brochure. I also understand as someone skilled	12:44:04p
21	in the polymer art that they're making an	12:44:08p
22	arbitrary distinction of molecular weight ranges	12:44:10p
23	and that there's a continuum of molecular weight	12:44:13p
24	ranges from 50,000 to 5 million and above, I'm	12:44:17p
25	certain.	12:44:19p

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		Page 320
1	BY MR. SABER:	12:44:20p
2	Q. Have you heard of the term	12:44:20p
3	conventional polyethylene?	12:44:31p
4	MR. BONELLA: Object to form.	12:44:34p
5	Asked and answered.	12:44:34p
6	THE WITNESS: I believe I	12:44:37p
7	answered that. I probably have, but it -- it	12:44:38p
8	has no specific meaning to me at this point,	12:44:42p
9	other than -- other than the attempts at this,	12:44:46p
10	as to this point undated brochure, attempting to	12:44:53p
11	use it.	12:44:55p
12	BY MR. SABER:	12:44:56p
13	Q. I believe I had asked you about	12:44:56p
14	commodity type, that's -- and if I asked you	12:44:59p
15	about conventional, then I apologize.	12:45:01p
16	A. Oh.	12:45:03p
17	Q. I mean, are you familiar with the term	12:45:04p
18	conventional polyethylene?	12:45:06p
19	MR. BONELLA: Objection. Asked	12:45:07p
20	and answered.	12:45:08p
21	THE WITNESS: Excuse me,	12:45:10p
22	Mr. Saber, I didn't hear the difference in your	12:45:11p
23	question, so let me try to answer your question.	12:45:13p
24	BY MR. SABER:	12:45:15p
25	Q. Sure.	12:45:15p

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	Page 328
1 is different than the strength of ultra high	12:53:02p
2 molecular weight PE?	12:53:06p
3 MR. BONELLA: Object to the form.	12:53:10p
4 THE WITNESS: It's purporting to	12:53:11p
5 describe a -- something called ECPE as one of	12:53:38p
6 the strongest fibers made pound for pound, which	12:53:42p
7 is density considered, of course.	12:53:45p
8 BY MR. SABER:	12:53:49p
9 Q. Do you agree that ECPE is one of the	12:53:49p
10 strongest materials made pound for pound?	12:53:52p
11 A. I can't comment on that right	12:53:58p
12 offhand. I expect it probably is, but I'm	12:54:01p
13 certainly not sure. Having not read this, I	12:54:06p
14 can't -- I can't tell you what's been developed	12:54:09p
15 as of today that might be stronger pound for	12:54:13p
16 pound.	12:54:16p
17 Q. Is it your understanding that this	12:54:26p
18 document is explaining that what they call	12:54:29p
19 conventional PE is not one of the strongest	12:54:32p
20 fibers pound for pound ever made?	12:54:37p
21 MR. BONELLA: And you're asking	12:54:51p
22 about the document. You had him read two	12:54:51p
23 paragraphs while asking a couple of questions	12:54:53p
24 about the document. Do you want him to read the	12:54:56p
25 whole document?	12:54:58p